INSTITUTE
***of* MUSEUM**
***and* LIBRARY**
SERVICES

Dear Colleague:

LIVING COLLECTIONS
Summer, 2000

Enclosed please find sample narratives, schedules of completion, and summary budgets from 4 successful applications from the 2000 and 1999 IMLS Conservation Project Support (CP) grant competitions.

The attached samples were selected because they demonstrate how individual institutions with different conservation needs successfully developed projects that address those needs. We feel these narratives are logically and clearly presented, and give sufficient information to support the request.

This packet contains 4 samples that represent different types of conservation projects. They emphasize the overall institutional conservation perspective, the involvement of conservation professionals in all phases of the project, and the importance of the project as the highest institutional priority for collections care.

In addition, there are three samples of funded education components. We hope that these samples give you the impetus to partner with your staff educators to develop your own creative way to educate the general public about your conservation project.

The samples included in this packet are listed on the back of this letter.
No endorsement by IMLS of any personnel, conservation facilities, private firms, or conservation procedures and methods identified in the narratives should be assumed.

I hope that these sample narratives will be useful to you as models for structuring a proposal for your conservation needs. IMLS program staff is available at
(202) 606-8539 or imlsinfo@imls.gov, and will be happy to discuss any questions you have as you develop your proposal.

The application deadline for the 2001 Conservation Project Support grant program is:

October 15, 2000

Applications for CP are available from the IMLS Web site (http://www.imls.gov), or by calling IMLS at 202-606-8539. We look forward to receiving your application.

Sincerely,

Mary Estelle Kennelly

Mary Estelle Kennelly
Director
Office of Museum Services

A Federal agency
serving the public
by strengthening
museums & libraries

Washington, D.C.

Sample Conservation Projects:

Project Type	Museum	State	IMLS Award	Total Project Costs
Environmental Survey	Rancho Santa Ana Botanic Garden	CA	$31,274	$63,757
Research	Cincinnati Zoo & Botanical Garden	OH	$73,785	$186,446
Environmental	Chicago Zoological Society	IL	$36,121	$99,157
Research	Toledo Zoological Gardens	OH	$38,489	$85,760

Sample Education Components:

Museum	State	Education Award	Total Grant Award
New England Aquarium	MA	$9,997	$36,720
San Diego Natural History Museum	CA	$10,000	$50,000
Tipton-Haynes Historic Site	TN	$9,175	$22,175

1. What is the design of the project?

The proposed conservation project combines 1) a continuation of a comprehensive plant mapping effort begun with a previous General Conservation Survey and 2) implementation of an environmental monitoring program. The recent completion of a General Conservation Survey funded in 1997 by the IMLS Conservation Project program has allowed the Botanic Garden to prioritize a series of conservation activities needed as part of a long-term, systematic effort to preserve the Botanic Garden's collections through both preventive and active conservation programs. This proposal addresses the Garden's two top conservation priorities as identified by the General Survey.

The plant mapping project and environmental monitoring program will each be broken down into several sub-projects scheduled to occur over a thirteen month period. The Schedule of Completion on page 7 also outlines these activities in greater detail. For the plant mapping component, the Garden's Director of Horticulture will serve as a co-project director and continue to supervise a crew of four staff members who are primarily responsible for mapping. For the environmental monitoring program, the Garden's four principal collections staff-the Administrative Curator of the Herbarium and co-project director for the environmental monitoring component, the Director of Horticulture, the Seed Curator, and the Librarian-will work with Dr. Paisley Cato (Curator of Collections at the San Diego Natural History Museum) as outside consultant to oversee the installation of environmental monitoring equipment and the implementation of a regular monitoring program.

Activity I: Plant Mapping (5/1/00 - 1/1/01). The Botanic Garden will continue its program of mapping the location and recording the general condition of the plants in the living collection. The plant mapping project will allow staff to accomplish two tasks for the long-term conservation of the living plant collections: 1) to specify the location and status of all accessioned plants in a 25 acre portion of the Garden located immediately north of a 30 acre area currently being mapped as part of an IMLS-CP grant (completion on-schedule for January 2000); and 2) to interface the plant records data contained in the plant records database (BG-BASE) with an interactive computer map of the Garden's collections (BG-Map). In the future, the Garden will seek additional funding to map the Garden's final 30 acre section.

In May 2000, the three person survey crew will begin work under the general supervision of the Director of Horticulture: the Curator Emeritus/Research Associate, two Field Technicians, and the Plant Record Manager as an alternate. They will inventory the 25 acre area of the Garden to verify each plant's condition, identification, and location. They will work from a list of every plant in the collection printed out from the plant records database, BG-BASE, according to their recorded grid location. They will then survey each 100 foot grid square to verify the presence or absence of each specimen and use electronic surveying equipment to assign coordinates within the grid to fix its exact location for the database. The coordinates are then downloaded into the computer and a draft map of the grid is produced by the Plant Record Manager. Labels are then produced for unlabeled specimens and qualifiers are added to the existing plant labels, and at the same time the draft map is field checked for accuracy). The survey crew then re-surveys any questionable plants, and a final map is produced for the grid square. Once this process is complete, the Curator Emeritus/Research Associate and the Plant Records Manager will deaccession any missing plants (i.e., place their records in a separate "dead file"), and correct the scientific name and information for any previously mis-identified plants. This step is time-consuming but critical to ensure that the records are accurate.

Once all the information has been entered into the computer, the database will allow staff to create a master list of all plants in the collection, and to conduct computer searches for the location(s) and condition(s) of specific plants or plant collections. This will be an important tool for determining what plants and collections to target for special care and maintenance, as well as to set priorities for adding new or replacement plant species. It will also be an important tool for use in determining what subcollections to target for future detailed surveys and to set priorities in the long-range plan.

Activity II: Environmental Monitoring (05/01/00 - 5/30/01, and annually thereafter). In April of 2000, the Garden's four collection managers—Administrative Curator of the Herbarium, the Director of Horticulture, the Seed Curator and the Librarian—will work with Dr. Paisley Cato, the Environmental Monitoring Consultant. With Dr. Cato's on-site supervision and assistance, they will set-up and implement the environmental monitoring program for the Garden's four major collections—the herbarium, the living collection, the seed collection, and the library. The environmental monitoring activities will have three areas of focus: 1) temperature and humidity monitoring for collection areas/rooms; 2) pest trapping in collection areas/rooms; and 3) obtaining new equipment for two outdoor weather stations to monitor climate conditions for the living collection. One herbarium technician will be assigned to assist with data collection from the temperature/humidity sensors and to check and replace traps (estimated at 5% time for one year), and one Gardener will be assigned to assist with data collection from the weather stations (estimated 2% time for one year).

Over the course of the initial 12-month monitoring period, data will be accumulated for each of the three areas of focus, with periodic contacts by Dr. Cato (weekly at first, then monthly or quarterly) to ensure that the equipment is operating properly. As the data is accumulated, it will be assembled for analysis at the end of the initial year. At that time, Dr. Cato will return to the Garden to assist in the review of the data and identify areas of concern suggested by the

monitoring program. Dr. Cato will also assist with drafting any revisions to the Long-Range Conservation Plan to reflect the finding's of the study.

Following the initial year of monitoring, the Botanic Garden's staff will continue the monitoring program on an ongoing basis, with funding for continued use of pheromone traps to be allocated from the Garden's general operating budget. Overall, the environmental monitoring program will provide critical and detailed information on the general environmental conditions of the collections, and inform future refinements of the Garden's Long-Range Conservation Plan.

2. What is the object(s), historic structure(s), or specimen(s) that is the focus of this project?

Herbarium. The herbarium contains over 975,000 specimens, and ranks 13th among the 300 or so museum collections (herbaria) in North America. It is particularly rich in specimens from California (#1 in the world for southern California), western North America, Mexico, Australia, the Pacific Islands, the former Soviet Union, and the Mediterranean basin. The collection has a broad phylogenetic representation, with most families and subfamilies of the flowering plants represented. Ancillary study collections of 6,000 wood samples, 20,000 pollen slides and 40,000 wood slides augment the primary collection. Over the ten years between 1987 and 1997, the herbarium accessioned more than 232,773 specimens to its collection, including 120,000 sheets from the vascular plant collection of the Los Angeles County Museum of Natural History, and annually accessions between 10,000 and 15,000 new specimens. The collection is designated as one of twenty-five National Resource Collections in the United States, only five of which are located in the West.

Living Collection. The Botanic Garden possesses one of the most complete living collections of California native plants in the world. 2,821 species, varieties and cultivated forms are currently grown—a figure that represents roughly 40 percent of the native flora. In addition, 299 taxa of rare, threatened and endangered native plants are maintained as living specimens on the grounds. Eighty-three acres are devoted to RSABG's collections. The *California Cultivar Garden,* opened to the public in April 1991, features a collection of over 800 cultivated varieties of California native plants. RSABG has developed and introduced 87 of these cultivars, many of which are highlighted in a special area of this display. Other major collections include a *Southern Riparian Woodland,* a *Home Demonstration Garden,* a *Woodland Garden,* a *Coastal Island Garden,* a *Desert Garden,* a *Palm Oasis,* seasonal Wildflower Displays, and a newly developed Wildflower Meadow. In addition, the Garden maintains a series of plant community areas that represent 19 of the 29 California plant communities originally identified by Munz and Keck. The most notable of these are the Joshua Tree Woodland and the Southern California Chaparral communities.

Seed Collection. The Garden's medium-term (or "active") seed collection contains nearly 2,200 accessions representing 1,393 taxa of native plants for use in research and display. In addition, as a founding member of the Center for Plant Conservation (CPC), the Botanic Garden maintains a long term seed collection to preserve rare and endangered plant species. Currently, 202 plant taxa (representing 519 accessions and approximately 7.3 million seeds) are maintained in the long-term seed collection for research and possible future reintroduction efforts. In most cases, the seed collections of these rare taxa represent the only *ex situ* germplasm in existence. In several cases, the seed accessions represent the only remaining germplasm of now extirpated wild populations.

Library Collections. The library's collection contains over 42,000 volumes including over 500 periodical subscriptions focusing on the flora of California, the western United States, the Pacific Basin, and other Mediterranean climate regions of the world. The collection is particularly strong in systematic botany and evolutionary biology—including floras of the world, taxonomic literature, and materials relating to California. It is also strong in California natural history, native plant horticulture, ethnobotany of the Southwest, water conservation, and drought tolerant landscaping. Special collections include rare books dating as early as 1525, a major reprint collection, all available California topographical maps, and the largest assemblage of nursery trade catalogues in the West. The library belongs to the On-Line Computer Library Consortium (OCLC) and it is linked to the Honnold Library of the Claremont Colleges which provides researchers and students access to the larger holdings of the Claremont Colleges consortium as well as other national network research services in the sciences.

Significance. RSABG's collections constitute a significant scientific, horticultural and educational resource for a community and region where species and habitat loss are critical issues. The flora of California is the largest of any state in the United States or province in Canada, comprising between 25 and 33 percent of the total number of known taxa in North America north of Mexico. Over 6,300 different kinds of native vascular plants grow here—a level of diversity that exceeds every other state including Hawaii. Not only is this floristic assemblage remarkable for the total number of species represented, but for its wealth of endemic species as well. Estimates of endemism in California are placed as high as 1,700 taxa (or 27 percent). Thus, California also contains about one-quarter of the federally listed endangered plant species in the U.S. As the most populous state in the U.S., the environmental impact of California's many commercial and agricultural centers is compounded by rapidly spreading residential and recreational developments. In the next 20 years, the State's population is expected to double from 30 million to 60 million. Not surprisingly, California also has the greatest number of plants—about 890— which are in need of some form of protection, and ranks high on federal priority lists. With population and associated pressures continuing, California is among the world's most endangered bioregions. For this reason, the Center for Plant Conservation has identified it as one of its five priority regions in the U.S.

3. How does the project relate to your museum's ongoing conservation activities?

The Botanic Garden recognizes the critical importance of a preventive approach to conservation— the maintenance of optimum environmental conditions and horticultural care as well as the use of appropriate handling, storage, display, and packing techniques to safeguard the plant specimens. Reflecting its commitment to improving collections conditions, in 1994 the Garden completed a $1.3 million Research and Horticulture Complex that significantly upgraded facilities for both the living plant collection and the seed bank. For the living plant collections, the new complex offers 3600 ft^2 of new greenhouse capacity, an indoor headhouse for "clean room" propagation of sensitive plants, a large outside work area (that is both roofed and heated for staff comfort and protection), a 1200 square ft. liner house, and a large 14,500 square ft. shade house for hardening plants prior to planting. For the seed program, the new complex includes a new 1,460 ft^2 seed storage laboratory equipped with both refrigeration and sub-zero freezer units for the medium-term and long-term collections, respectively.

The present herbarium facilities in a 45-year old academic building do not, however, provide adequate space for collection growth, and climate conditions are not properly monitored for variations in temperature and humidity. And, while the herbarium has a regular program of inspecting for pest infestation, pheromone traps are not currently employed as a part of the pest monitoring program. The living collections are, of course, intentionally maintained outdoors in "natural conditions." Nevertheless, RSABG also recognizes the periodic need to replace and upgrade major infrastructure items such as the Garden-wide irrigation system, and would like to acquire computerized weather stations to improve climate monitoring. These, in turn, will help maintain healthy collections by allowing irrigation regimes to be more responsive to short-term weather changes and to better mimic normal rainfall patterns during times of drought.

Thus, the conservation of collections is a high priority of RSABG, but past efforts have proceeded without the benefit of a systematic plan. In 1997, the Garden began an effort to methodically address conservation issues when it applied for and received an IMLS-CP grant for a General Conservation Survey of the Garden's three main botanical collections: herbarium, living collection and seed collection. This was followed shortly thereafter with a separate, privately funded conservation assessment of the Garden's library collection (both Surveys are included as Exhibits A and B, respectively, in "Supporting Documents").

The General Survey included three major areas of activity: 1) the General Survey of the Collections, 2) plant mapping of a 30 acre portion of the Garden (the first of three planned phases, each covering approximately 1/3 of the Garden's total acreage), and 3) development of a Long-Range Conservation Plan. Of these three activities, the General Survey was completed in the Spring of 1998, the 30-acre plant mapping project will conclude in January 2000, and the Long-Range Conservation Plan is scheduled for approval by the Garden's Board of Trustees at its December 1999 meeting. Thus, all activities of the current IMLS-CP grant will be completed by January 31, 2000.

While the Long-Range Conservation Plan is not yet approved, a draft of the LRCP is under active development and is already being used to organize and prioritize the Garden's conservation efforts (because it is not yet approved, and may be subject to revision, the draft plan is not included with this proposal). Nevertheless, several institutional priorities have been identified in both the draft LRCP and General Survey. These include: 1) standardization of the Garden's collections management policies for each of its, major collections; 2) completing the two remaining phases of the plant mapping project; and 3) initiating a regular environmental monitoring program for the collections. These three are the highest priorities because each helps provide the framework needed to establish collection care program that focuses on prevention rather than remedial treatment of conservation problems.

The development of standardized collections management manual will be undertaken as a near-term project by the Garden's four collections managers, and will not require external funding since it will be handled in-house through the allocation of staff time. The plant mapping project and the environmental monitoring program, however, both require additional external resources to enable them to move forward in an expeditious manner. For that reason, the Garden is now seeking funds from the Institute of Museum and Library Services Conservation Project Support Program to address these two vital needs.

4. What are the anticipated benefits of this project?

On a broad level, the plant mapping project and environmental monitoring program will benefit the Botanic Garden by providing it with the necessary tools and information to maintain and improve the condition of its living and non-living plant collections. For example, the plant mapping project will allow the Garden to map the second 1/3 section of its living collections. Because the living collections undergo a constant and "natural" process of change, it is especially important to maintain accurate, up-to-date information concerning their location and condition as part of an over-all collections management strategy. The plant mapping component will create a computer data set that identifies the location and basic condition of the specimens in the 25 acre project area. This information will provide an invaluable tool for the horticultural staff in their daily work with collections.

By gathering environmental data, the monitoring program will allow staff to assess variations in temperature and humidity levels in collections storage areas, to identify potential collections threats from pests, and to monitor outdoor weather conditions to make adjustments to plant care regimes. For the indoor collections areas, accurate and timely monitoring of these kinds of general environmental conditions allow staff to identify problems before they result in severe

deterioration or damage to collections, and are the foundation of any effective preventative conservation program. For the outdoor areas, the two new weather stations will allow the Garden to respond to day-to-day changes in climate and reduce the stresses on living plant specimens. And, as with the mapping project, the data sets generated by the monitoring program will be used to update and revise the LRCP as circumstances warrant it.

5. How will the applicant ensure that ongoing museum functions are not inhibited by these project activities?

Although each of the four collections managers will devote a percentage of time to the project, the plant mapping project and environmental monitoring program are not expected to conflict with their regular duties and activities. The plant mapping project will require a greater on-going percentage of effort from the Director of Horticulture and the Plant Records Manager; however, the Director of Horticulture will limit involvement to general supervision (about 6 hours per week or 15% time). A substantial portion of the Plant Records Manager time will be-assigned as an in-kind contribution to the project, but she will continue to spend a minimum of 40% of her time on routine departmental tasks. All curatorial-level work will be handled under contract by the Garden's former Curator of the Living Collection (now a Research Associate). To further reduce the impact of the plant mapping project on the horticulture staff, the Garden will hire two field technicians to handle the actual mapping activities. The environmental monitoring program will require a few days of initial staff time to work with the consultant to set-up the monitoring equipment, but only a few hours per month thereafter to collect and download the computerized data into a central computer. This information will also, once collected, will again require only a few hours of time each month for analysis and interpretation by the relevant collections managers.

RSABG will ensure that adequate resources are allocated to the total project by obtaining outside funding for out-of-pocket expenses, and allocating staff time (salaries, benefits and indirect costs) to the project. The plant mapping project is expected to continue for several additional years with substantial external as well as internal financial support, but the monitoring program will continue to be maintained by the Garden through an increase in the general operating budget to cover annual consumable supplies and the staff time needed to continue collecting and analyzing the temperature and humidity data.

In the future, the Garden will support conservation in several ways. First, it will continue to increase its own operating budget commitment to conservation. Second, it will continue to seek federal grants through IMLS and other agencies—the Garden has had generally good success with its past grant proposals to agencies such as IMLS, NSF, and NEH, and will continue to seek moneys from federal sources. And third, it will seek funds for projects through private foundations and corporations, such as the Confidence Foundation and ESRI, and private individuals with a history of giving to the Botanic Garden. Through the combined funding opportunities represented by the operating budget, and government and private sources, the Garden will initiate an ongoing program of conservation projects designed to preserve and safeguard its collections for the future.

6a. What are the proposed conservation methods and why are they conservationally sound?

The mapping phase of the project will involve an inventory of the location and condition of the plants in the southern Mesa area of the Garden. The mapping project will use electronic surveying equipment (the Total Station Interface System acquired with the previous grant) that is capable of directly recording grid locations on a hand-held computer in the field, and then later down-loading those locations into the main BG-BASE database. This set-up will allow for an extremely efficient data entry process, with the Curator Emeritus and Field Technicians recording the location of plant specimens and handling the automated transfer of the data into BG-BASE. The plant mapping of the 25 acre section of the Garden will begin in May of 2000, and will continue for 8 months.

The monitoring program will also begin in May 2000, and will continue for an initial 12 month monitoring period. At the conclusion of the first year, Dr. Cato, the environmental monitoring consultant, will assist with a final review and interpretation of the initial results from both the monitoring equipment and the pest traps. Dr. Cato will also assist with suggested changes to the Long-Range Conservation Plan based on the monitoring data.

For the monitoring program, the Garden will acquire a number of new equipment items and expendable supplies. For temperature and relative humidity monitoring in collection storage areas, the Garden will purchase 11 HOBO H8 data loggers. These units are currently in use at the San Diego Museum of Natural History, and do not require user calibration. Along with the units, the Garden will purchase a "data shuttle" to make it easier to download data from these digital sensors, as well as proprietary software (Box Car Pro 4.0) to facilitate analysis and interpretation of the data. One set of replacement batteries will also be acquired at that time. For pest trapping, the Garden will purchase standard Serrico Cigarette Beetle Traps. Both the HOBO data loggers and the pest traps will be distributed in the collection storage areas according to a pattern identified by Ms. Sally Shelton, the lead consultant for the previous General Conservation Survey. Dr. Cato will review Ms. Shelton's suggested spacing, and make on-site adjustments as appropriate.

Finally, the Garden will purchase two EZ-Mount GroWeather Stations (including console with barometer, anemometer, rain collector, temperature and temperature/humidity sensors, solar radiation sensor, leaf wetness sensor, ET data logger, radiation shield and weather resistant shelter) for placement outdoors within a secured fence enclosure. The Garden would like to purchase two stations because the size and natural topography of the site suggests that there are at least two

significant micro-climates which should be monitored independently. Product information is included in Exhibit C for each of these major equipment and supply components identified, above.

7. How does the project budget support the project goals and objectives?

The budget for the general conservation survey was developed around the project plan worked out with the four collections managers. Additional efforts went into the planning for the plant mapping component as it is the most complex element requiring the greatest coordination. Staff identified both ideal and minimum requirements for each component: plant mapping and environmental monitoring. Adjustments were then made within the context of available and anticipated funding levels from the operating budget and potential outside sources to arrive at a reasonable budget that would still ensure a successful project. One example was the decision to map the southern 30 acres of the Garden in the first IMLS-CP grant, and to extend the mapping project into the remaining acreage through two subsequent phases. Existing and potential resources were allocated such that RSABG would support costs for the regular full-time staff assigned to the project ($32,483 including indirect costs), and that funding from IMLS would support costs for the staff time (temporary or project specific) for the mapping project, the general survey consultants, and the consultant travel ($31,274).

8. What are the qualifications of the project personnel?

Steve Boyd, RSABG Administrative Curator of the Herbarium and Co-Project Director, will oversee the environmental monitoring program. He holds a B.S. in biology and an M.S. in botany from UC Riverside, and has worked in herbaria both at UC Riverside and RSABG. Mr. Boyd served as Project Director for the Garden's 1997 IMLS-CP award for a General Conservation Survey, and has also served as Principal Investigator for two major NSF collections care grants, one of which provided for the transfer of 120,000 specimens from the Los Angeles County Museum of Natural History to the RSABG herbarium.

Bart O'Brien, RSABG Director of Horticulture/Curator of the Living Collection and Co-Project Director, will participate in the environmental monitoring program and oversee the plant mapping project. Mr. O'Brien holds a B.S. in environmental planning and management from UC Davis, and a Master of Landscape Architecture from the Harvard University Graduate School of Design. He has held the position of Director of Horticulture since 1990, and previously was the nursery manager for Yerba Buena Nursery, which specializes in California native plants.

Mike Wall, RSABG Seed Curator, will participate in the environmental monitoring program. Mr. Wall graduated from Fullerton College with a degree as a Landscape/Horticulture Technician in 1977 and received a certificate in Horticulture from Cal-Poly Pomona in 1985. He has worked in the Seed Program since 1996, and is actively involved in the Center for Plant Conservation.

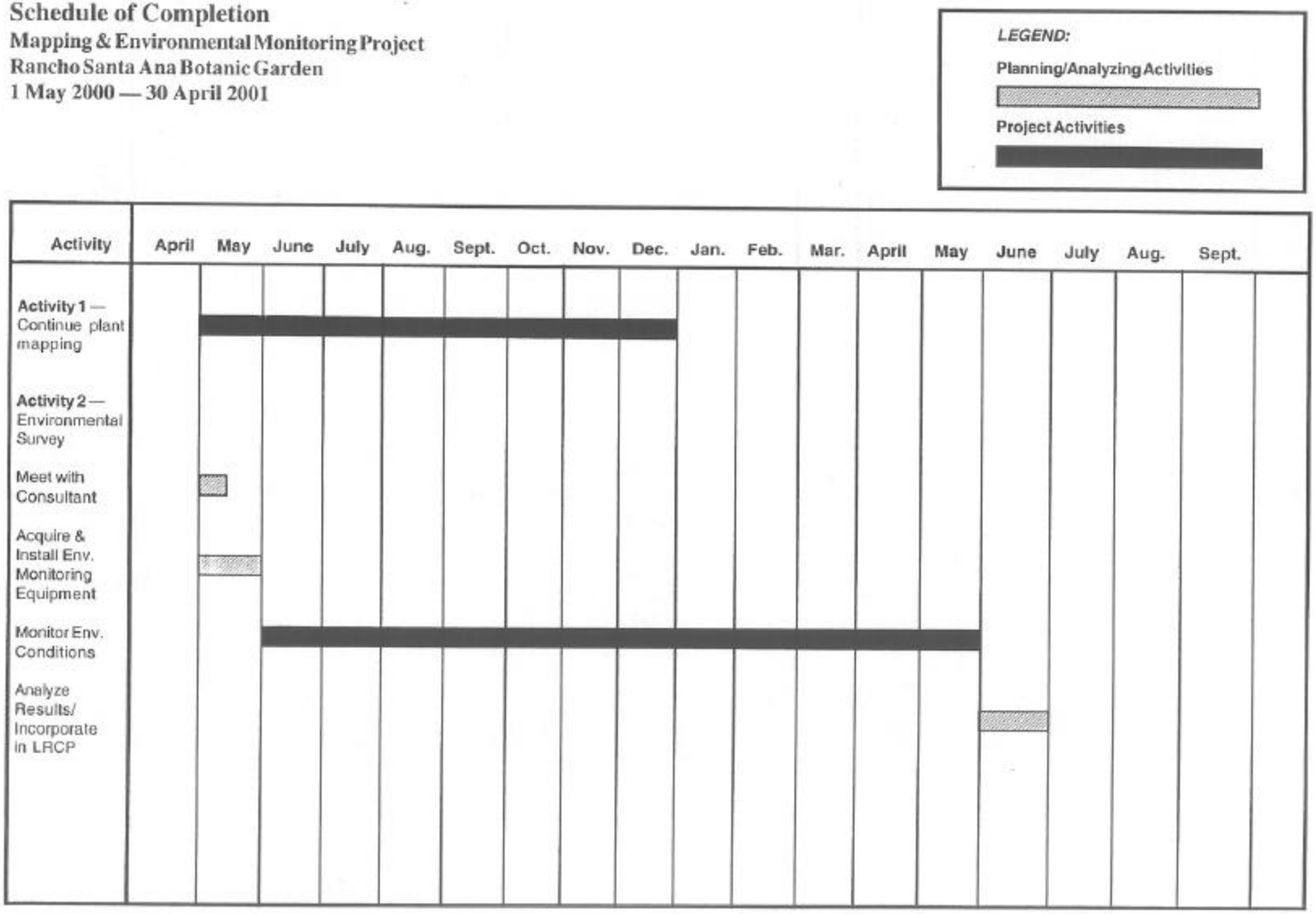
Bea Beck, RSABG Librarian, will participate in the environmental monitoring program. Ms. Beck holds a B.A. in Psychology and Eduation from Whittier College, and an M.S. in Library Science from the University of Southern California. She has served as the Garden's Librarian since 1970, and is actively involved in the Council of Botanical and Horticultural Librarians, the California Library Association, and the American Library Association.

Walter Wisura, RSABG Curator Emeritus of the Living Collection and Research Associate, will assist as a contract employee with the plant mapping component, providing information on plant identification and condition. Mr. Wisura holds a Diploma in Horticulture from the Horticultural Academy in Berlin, Germany. He has worked with the Garden's living collections for nearly 20 years, with twelve years experience as Curator of the Living Collection.

Paisley Cato, Ph.D., Curator of Collections, San Diego Natural History Museum, is nationally recognized for her contributions to the conservation of natural history collections. She holds a B.A. in Zoology from Smith College, an M.A. in Museum Science from Texas Tech University, and a Ph.D. in Wildlife and Fisheries, Museum Science Specialty, from Texas A&M University. She has been a project director on numerous conservation projects (many funded by IMLS), and lectures widely on principles of collections management and conservation for natural history collections.

Schedule of Completion

Mapping & Environmental Monitoring Project
Rancho Santa Ana Botanic Garden
1 May 2000 — 30 April 2001



Project Budget Form

SECTION 3: SUMMARY BUDGET - CP AND EDUCATION COMPONENT

Name of Applicant: Rancho Santa Ana Botanic Garden

IMPORTANT! READ INSTRUCTIONS IN PART 4 BEFORE PROCEEDING.

DIRECT COSTS	IMLS	MATCH	TOTAL
SALARIES AND WAGES (PERMANENT STAFF)	-0-	20,178	20,178
SALARIES AND WAGES (TEMPORARY STAFF HIRED FOR PROJECT)	23,296	-0-	23,296
FRINGE BENEFITS	-0-	5,892	5,892
CONSULTANT FEES	900	-0-	900
TRAVEL: DOMESTIC	84	-0-	84
FOREIGN	-0-	-0-	-0-
SUPPLIES & MATERIALS	6,994	-0-	6,994
SERVICES	-0-	-0-	-0-
OTHER	-0-	1,000	1,000
TOTAL DIRECT COSTS	$ 31,274	$ 27,070	$58,344
INDIRECT COSTS*	$ -0-	$ 5,414	$ 5,414

* *If you do not have a current Federally negotiated rate, your indirect costs must appear in the Match column only.*

TOTAL PROJECT COSTS $ 63,757

AMOUNT OF CASH—MATCH $ 32,483

AMOUNT OF IN-KIND CONTRIBUTIONS—MATCH $ -0-

TOTAL AMOUNT OF MATCH (CASH AND IN-KIND CONTRIBUTIONS) $32,483

AMOUNT REQUESTED FROM IMLS $31,274

PERCENTAGE OF TOTAL PROJECT COSTS REQUESTED FROM IMLS (MAY NOT EXCEED 50%) 49 %

Have you received or requested funds for any of these project activities from another Federal agency? *(please check one)* ☐ Yes ☒ No

If yes, name of agency _____ Date _____

Amount requested $ _____

Cincinnati Zoo & Botanical Garden
Ohio
Research

1. What is the design of the project?

The goal of the proposed project is to develop and apply tissue culture propagation protocols for a group of highly endangered plant species which are in the Center for Plant Conservation (CPC) National Collection of Endangered Plants and which are experiencing reproductive difficulties. The specific objectives of the project are to 1) propagate the species using appropriate tissue culture methods at the Cincinnati Zoo and Botanical Garden (CZBG)s Center for Research of Endangered Wildlife (CREW); 2) return propagated material to the CPC garden from which it came; and 3) preserve all tissue culture lines resulting from this project at CREW in cryostorage as a back-up, in accordance with the official CPC/CREW Cooperative Agreement (see Appendix A).

Project Activities

Targeted Species. A group of 23 species (Appendix B) from the National Collection of Endangered Plants has been identified which could benefit from in vitro research. These species fall into two categories: 1) species which have not been cultured before or which have only recently been put into culture; and 2) species for which cultures have been established, but which are not responding well to standard protocols. Standard protocol are outlined in Appendix C. Project activities for group 1) will focus on applying standard techniques, as developed in this lab and in others. Activities for group 2) will center on the use of experimental procedures, including research identifying physiological differences in these taxa which correlate with their response, or lack thereof, in vitro.

Group 1. Species which have not been cultured previously. The species must first be evaluated as to the type of material which is available for culture and the needs of that particular species. Protocols which have been used on related species will be studied (Appendix C) to determine which are most likely to be successful, and these will be tried first. Depending on the results of these tests, modifications in protocols or the application of new protocols will be made. A variety of approaches are available, as described below, depending on the tissue and the problem involved. This lab has experience in all of these procedures.

Seed germination. For species with some available seed, a portion will be used for in vitro germination, to obtain seedling tissue to use to establish shoot tip cultures (see below). In the case of *Pholisma sonorae*, seed of this parasitic species germinates only in the presence of the host plant. Cultures of one host species, *Tiquilia*, are currently growing at CREW. Attempts will be made to combine dormancy-breaking techniques with roots or root extracts from the host plant, in order to stimulate development of the embryo and, finally, germination. In the case of the orchid, *Spiranthes delitescens*, preliminary work here has provided protocols for seed germination which will be used in this study. Because the seeds of orchids contain no stored food and require the association of a fungus for germination in soil, the germination of orchid seeds on nutrient medium in vitro is a standard procedure for commercial orchid propagators. Seedling material would then be used for shoot multiplication. This strategy has recently proved successful in this lab with another endangered orchid, *Spiranthes deluvialis*. ***Embryo Germination***. When dormancy is suspected, embryos will be dissected from the seed for in vitro germination. This strategy has been successful in this lab with several rare species, including *Aster vialis* and *Primula maguerei*. *Somatic Embryogenesis.* In addition to seed germination, immature or mature embryos, or immature leaves or flowers, can be cultured, to stimulate somatic embryogenesis or shoot initiation. This strategy has been used in this lab with *Primula maguerei* and *Calamagrostis porteri* ssp. *insperata*. ***Shoot Tip Culture***. Shoot tips from seedlings or from cuttings can be used to initiate shoot cultures which can be maintained to produce plants. This has been used successfully in this lab with several endangered species, including *Aster vialis andAsimina tetramera.* When needed, shoot tips can taken from plants in the wild using the technique of in vitro collection (see below), and this has been successful for initiating cultures of *Rhexia aristosa*, *Lobelia boykinii*, and *Shoenocrambe suffretescens*. ***Young Leaf and Stem Culture.*** Using various hormone combinations, young leaf and stem tissues of many species can be stimulated to produce shoot buds. These can then be used to initiate shoot cultures and produce plants, as has been done in this lab with several species of *Trillium*, including the rare *T. persistens*. ***Rooting of Shoots***. Once shoots are obtained in vitro, they will be rooted on rooting media or as cuttings in sterile soil.

Group 2. Species for which standard procedures have not been adequate. Some species do not respond to standard protocols. Species in this group fall into three categories: 1) those which show extreme browning in vitro; 2) those which are difficult to root; and 3) those which tend to become hyperhydric in culture. ***Species with Extreme Browning.*** Three species proposed for study in this project, *Dicerandra immaculata*, *Dicerandra* Lake Pierce, and *Agalinis navasotensis* appear to have a strong browning reaction to wounding or stress. This represents the oxidation of phenolic compounds, and is normal in many plants, but it can inhibit growth of the tissues in vitro. Approaches to controlling browning generally center on the use of antioxidant chemicals, such as ascorbic acid or activated charcoal, as well as

through controlling environmental conditions which may affect oxidation, such as light and aeration. These will be tested with species of *Dicerandra* as well as *Agalinis navasotensis*. ***Difficult-to-Root Species***. These species will be tested for their responses to the rooting hormone, auxin, but other approaches wifi also be taken. For example, since *Asimina tetramera* shoots can sprout from roots in situ, root cultures will be established to determine if shoots can be formed on roots in vitro. Other approaches will focus on the possibility that hormone levels in these shoots are not permissive of root formation. In general, a higher level of auxin and lower level of cytokinin is needed for root initiation. Hormone levels in shoot bases will be measured by enzyme-linked immunosorbent assay (ELISA), a technique which has been used previously in this lab (e.g. Pence, 1992). If endogenous levels of cytokinins appear to be excessive and/or the level of auxins seem low in species which will not root, measures aimed at altering the endogenous levels of these hormones, such as liquid medium or the use of chemical hormone antagonists, will be used. ***Hyperhydric Species.*** Some of the taxa already in tissue culture readily become "hyperhydric" in vitro. Hyperhydricity refers to a "glassy"- or 'watery" - looking state in stems and leaves of cultured tissues. Such tissues are abnormal and do not root or acclimate well. Current thinking on hyperhydricity centers on the overproduction of endogenous cytokirtins in the tissue, but this appears to be influenced by a number of factors. Research on CPC taxa showing hyperhydricity in culture will center on altering media and environmental conditions to obtain more normal plantlets. After working with a number of CPC species from different environments over the past several years, the following hypothesis has been formulated: that species which come from an arid environment are more inclined to become hyperhydric in vitro than those from a moist environment. Thus far, the three species which appear most inclined to hyperhydricity are *Hedeoma todsenii, Shoenocrambe suffretescens,* and *Primula maguerei,* all of which come from arid environments. On the other hand, species which have not shown hyperhydricity, under the same conditions, include *Asimina tetramera, Rhexia aristosa, Lobelia boykinii, and Arenaria cumberlandensis,* all of which grow in more humid environments. Testing this hypothesis is beyond the scope of this grant, and will be done in other studies with nonendangered species. However, a second hypothesis will be tested: that plants which are hyperhydric in vitro have higher cytokinin levels and lower abscisic acid (ABA) levels than plants of the same species with normal morphology. (ABA is a hormone involved in stress tolerance.) This will also be done by using the technique of ELISA to measure the cytokinin and ABA levels in these tissues. This will provide valuable information on hyperhydricity in general, but more importantly, wifi provide a framework in which to work to try to modify the endogenous hormonal levels of these tissues, thereby reducing the hyperhydricity response.

Other Procedures. ***Weaning of Plants.*** Moving plants from the high humidity of in vitro conditions to soil requires acclimatization procedures which may involve media changes and manipulation of light, gases and humidity in the plant's environment. *Preservation of Tissue Culture Lines.* Several cryopreservation protocols are used in this laboratory, and each species line will be evaluated to determine which procedure is the most applicable to the tissue in question. ***Genetic Sampling.*** Sampling will be done from as many individuals as possible to represent a substantial amount of the genetic diversity of the species. Tissue culture lines generated from these samples will be maintained separately and plants produced will be identified by line. *In Vitro Collection.* For sampling, the technique of *in vitro collection* (IVC), or initiating tissues in the field, may be used if it is appropriate for a particular species. IVC has the advantage of utilizing very fresh tissues, of causing minimal disturbance to the plant in situ, and providing an efficient method of transporting samples back to the lab. ***Return of Plants to the Collaborating Garden.*** Once plants are acclimatized and growing in soil, they will be returned to the garden from which the original material came. In some cases, plants may be returned to the garden in vitro for acclimatization there in a more suitable habitat.

Staff. With the support of the IMLS, one full-time Research Assistant will be hired to work on the tissue culture propagation of the selected plant species at CREW. Dr. Pence will devote 25% of her time to working with the person on the design and implementation of protocols for each of the target species as well as to measuring hormones with ELISA for this project. In addition, one CREW Research Associate wifi devote 20% of the time to the tissue culture and cryopreservation aspects of the project. The staff at the collaborating CPC gardens (Appendix B) will be responsible for the collection and shipment of plant materials and for providing background information on the species. Dr. Brien Meileur at the CPC will assist in coordinating activities with the gardens and in maintaining the National Collection.

Schedule and Products. The number of species proposed here is higher than that included in the previous IMLS proposal, because of experience gained in that previous work and the fact that some of the proposed species are already in culture (Appendix D). Some species from previously funded work are included here, since either plant material has not yet been available, has only recently become available, or the species poses particular challenges to tissue culture, as noted above. Based on preliminary work with some of these species and the IMLS-supported work on other endangered species, the number of species is appropriate for the schedule of time and the personnel included within this proposal.

The results of these studies will be written into one or more papers for scientific publication in journals such as *In Vitro Cellular and Developmental Biology--Plant; Micro propagation News; Plant Cell Tissue and Organ Culture;* and *Plant Cell Reports,* and will be presented at least one meeting of the Society for In Vitro Biology. Information will also be disseminated to other CPC gardens through the CPC newsletter and to the CZBG community through its

publication, *Wildlife Explorer*. (See Appendix E for presentations and publications thus far on IMLS funded work.)

2. What is the object(s), historic structure(s), or specimen(s) that is the focus of the project?

All of the proposed species are of very limited range. In addition, they have problems in reproduction, or, in a few cases, in germplasm storage, and/or they are in need of assistance in building up their numbers in the National Collection. They represent the 'critical cases' within the CPC National Collection. Specifically, *Spiranthes delitescens* has been reduced to only 4 populations and is threatened by illegal collecting and the decline of habitat quality; *Pholisma sonorae* is a sand dune endemic threatened by habitat loss; *Ranunculus aestevilis* is known from only one site, and in 1994 only 4 adult plants were found; *Asimina tetramera* and *Deeringothamnus rugelii* are few in numbers and set few seeds; *Hedeoma todsenii* does not set much seed, either in the wild or in cultivation, while *Astagalis cremnophylax* var. *cremnophylax* also has low seed set in the wild; *Trillium pusillum* var. *texanum* is limited in range and very slow to propagated; *(species name omitted)* has a very limited range and produces no seed; *Schoenocrambe suffretescens* is known from three small populations and seed germination has not been successful; *Primula maguerei* is found on steep cliffs and is at risk from climbers and road construction, and seed cannot be germinated; *Asclepias meadii* is a rare prairie species which has suffered from habitat loss, and some populations produce no seed; *Isoetes Iouisianensis* and *Isoetes tegetzformans* are known from only a few sites and require methods for germplasm preservation; *Clematis socialis* is found in only 3 or 4 populations in the wild; *Dicerandra* species and *Sagittaria fasciculata* are limited due to habitat loss and require methods for germplasm storage; *Agalinis navasotensis* is known from only 1 site in the wild; *Aconitum noveboracense* is declining due to habitat degradation; *Ziziphus celata,* known from only 3 sites, requires an increase in numbers to maintain populations as well as for phytochemical testing; *Mespilus canescens* is known from only 1 site with 25 individuals and is slow to propagate in captivity.

Each of these is a unique species with importance as part of its natural habitat and of importance as a species for potential utilization by humankind. Species of *Ziziphus* have been used in traditional and western medicine. Biologically active chemicals from related *Asimina* species have been studied extensively, while species within the Ranunculaceae are also known to produce alkaloids and other biologically active compounds. Members of the Brassicaceae have been shown to contain anti-carcinogenic compounds. Species of the Lanüaceae (mint family) are well known for their volatile oils, flavorings and scents, while members of the Orchidaceae, Isoetaceae, Liliaceae, Primulaceae, Rosaceae, and Ranunculaceae are horticulturally important as ornamentals. The potential for the usefulness of wild species is not always known, but if these rare taxa are lost, it will be impossible to evaluate what they may have to offer humankind. Many of them are congeners with economically important species (Phillips and Meilleur, 1998)

Founded in 1984, the CPC is the only organization in the U.S. whose pupose is to prevent the extinction of native plants. The CPC is a consortium of twenty-eight botanical gardens and arboreta nationwide that collectively maintain endangered plants in the National Collection of Endangered Plants, which currently includes more than 450 species, making it one of the largest conservation collections in the world. The CPC's mission is to create a systematic, comprehensive national program of plant conservation, research and education.

The Cincinnati Zoo and Botanical Garden is committed to the understanding and preservation of wildlife and our living world through naturalistic exhibits of animals and plants, scientific research, education, and active cooperation with a worldwide network of conservation organizations. The CZBG is home to the largest botanical garden in the region, which features one of the most extensive collections of perennials, flowering trees and shrubs in the nation. Currently, there are more than 2000 species of plants represented in the CZBG collection.

The CZBG's dedication to conservation science is displayed in its world-renowned research division, CREW. Established in 1981, CREW's mission is to use science and technology to understand, preserve, and propagate endangered flora and fauna and to facilitate the conservation of global biodiversity. The propagation and preservation of endangered plant species is aided throughout the application of tissue culture propagation, in vitro collection, and cryopreservation of seeds, embryos, shoot tips, spores, gametophytes, pollen and cell cultures. CREW's Frozen Zoo and Garden is a collection of a wide variety of rare plant and animal germplasm stored in liquid nitrogen, providing a "back-up" of genetic material for future use.

In the true spirit of both organizations' missions, the CZBG CREW and the CPC and its member gardens are collaborating to enhance the propagation of highly endangered species in the National Collection of Endangered Plants. The proposed research will not only work to preserve the 23 species listed, but will act as a model for the preservation of other highly endangered plant species. Working in cooperation with 9 botanical gardens geographically dispersed throughout the U.S., the CPC and CREW researchers have targeted these species because of their rarity and uniqueness. The preservation of these species will have both local and national impact as each species is endemic to the habitat in which its participating garden is located and each species is part of the National Collection of Endangered Plants.

3. How does the project relate to your museum's ongoing conservation activities?

A central focus of CREW research is found in its Plant Conservation Division (PCD), which was established in 1986 to adapt the biotechnologies of plant science to the preservation of rare and endangered plants. Over the last 13 years, the PCD has made significant strides in its Endangered Species Propagation Program (ESPP), developing tissue culture techniques for those species which are experiencing reproductive difficulties, as well as developing cryopreservation protocols for the long-term storage of rare species.

PCD researchers were the first to culture various species of *Trillium,* including the rare *Trillium persistens* (Pence and Soukup, 1995). Since then, IMLS-EP funding has supported work on over 20 of this country's most endangered species (see Appendix D for summary). *Aster vialis, Sisyrinchium sarmentosum, Calamagrostis porteri* ssp. *ins perata, Lobelia boykinii, Rhexia aristosa, Arenaria cumberlandensis, Crotalaria avonensis, Spiranthes deluvialis, and Redyotis purpurea* var. *montana* have all been successfully propagated in vitro, and the tissues have been or are in the process of being cryopreserved for long-term maintenance in CREW's Frozen Garden. Plants of these species have been returned to the collaborating gardens or will be returned in the next several months. Work with another target species, *Plantago cordata,* indicated that the seeds, while short-lived in nature, were not recalcitrant as originally thought, and that they could withstand drying and cryopreservation (Pence and Clark, in revision). They are now being maintained in the Frozen Garden at CREW. In vitro techniques are in various stages of development for several other species.

The species chosen for this work from the National Collection are, by definition, critically endangered. They are also those for which traditional propagation methods have proven unsuccessful or inadequate to meet the conservation needs of the species and they are thus of highest priority for this research.

Other related conservation research in the PCD includes the in vitro propagation and cryopreservation of nonseed plants, including pteridophytes (ferns and affied species) and bryophytes (mosses and liverworts) and the seed banking of species which are regionally threatened. A previous IMS-CP grant enabled the PCD to accelerate the development of optimal long-term storage methods for threatened and endangered plant species native to Ohio. Ongoing work is directed at improving the technique of in vitro collection, which has been used to collect tissues from species in the National Collection, as well as species from Trinidad and Costa Rica. The PCD also supports basic research on desiccation tolerance, which is critical to seed storage protocols, and the hormonal basis for regeneration and growth of plant tissues in vitro.

4. What are the anticipated benefits of this project?

The role of scientific discovery increases as zoos, botanical gardens, and arboreta continue their evolution from recreation centers to centers for conservation. The proposed research wifi benefit these museums by establishing protocols for the reproduction of highly endangered plant species. The research conducted with the 23 species included in this project will 1) provide baseline information for application to the multitude of similarly endangered and reproductively disturbed plant species found in collections throughout the world; and 2) provide a reserve of genetic material in both the living collections of the participating CPC gardens as well as in liquid nitrogen storage in the Frozen Garden at CREW.

The project results will be used well beyond the duration of this two-year project. Just as PCD researchers are using past research on the tissue culture propagation of a wide variety of plant species as a basis for developing protocols for work with new species, it is anticipated that other researchers wifi use the results of this project as a basis for further studies. Plant tissue culture is still largely an empirical science, and the information gained from each project increases researchers' collective knowledge of the role that tissue culture propagation can play in enhancing the reproduction of endangered plant species.

Research results will be shared with other institutions through publications in peer reviewed journals and presentations at professional meetings. For example, Dr. Pence and colleagues have presented the results from IMLS-EP grant research at several meetings, as oral presentations and posters, and have several papers in revision or preparation (Appendix E). This project has the support of each participating garden, as well as of the CPC (Appendix F). Therefore, the CPC and its participating gardens will be informed of the progress of the research throughout the duration of the project.

How will the applicant ensure that ongoing museum functions are not inhibited by these project activities?

CREW has occupied its state-of-the-art facility for more than eight years. This facility was constructed solely for research and education; therefore, new projects are undertaken on a regular basis without disrupting the Zoo and Botanical Garden's general operations. CREW grant monies are maintained separately from general funds and are closely monitored by the Director of Research, CREW Principal Investigators, and the Zoo Comptroller. Monies awarded from this Exceptional Project wifi be monitored following this same procedure to ensure that funds are expended for purposes designated in the project budget.

General operating support is generated through a combination of Zoo operating support and CREW fund raising,

grant writing and earned income. These funds will be used to match IMLS grant monies.

The hiring of a specialized Research Assistant dedicated solely to this project wifi enable CREW's PCD to conduct this research without inhibiting institutional functions.

6a. What are the proposed conservation methods and why are they conservationally sound?

Tissue culture and cryopreservation methods are being proposed for the 23 selected species in order to revive populations of these species for which traditional methods of propagation and preservation are not adequate. There is a large body of tissue culture literature to draw upon in designing specific protocols for the treatment of the plant material (see Appendix C). A growing collection of bibliographic information (currently >19,000 references) as well as a growing library of articles on plant tissue culture are maintained at CREW as the Plant Tissue Culture Database, providing the PCD with efficient access to this information. By adapting procedures used with related or similar species, the most efficient use of resources will be made, and the possibility of success with these species will be maximized. Any procedures which are developed in the course of these studies will be published and made available to the plant conservation community. Those doing tissue culture propagation of endangered species will benefit from the protocols produced in these studies.

Tissue culture propagation is a clonal process. Thus, in order to maximize genetic diversity, seed or embryo germination will be of highest priority. If clonal techniques are needed, plants will be propagated from *each one* of the seeds or plants sampled. These lines will be maintained separately, and the resulting population of plants will reflect the *same* genetic diversity as the original seedling or plant population, but the potential will exist for producing more than one plant of each type.

The occurrence of *somaclonal variation,* or genetic changes, can occur during tissue culture. Since propagation from previously formed buds (micropropagation) appears to present the lowest probability of somaclonal variation, it is preferred over techniques which include a regeneration step. Regeneration will be used when micropropagation is not successful, and in all cases, propagated plants will be evaluated for their phenotypic trueness-to-type. However, there is evidence that in some cases somaclonal variants can be later normalized, suggesting that when changes are occurring they are not always permanent mutations (Vasil, 1994).

7. How does the project budget support the project goals and objectives?

The budget for the proposed project was developed based upon a number of factors. The intensive research dedicated to this project will require a full-time Research Assistant. Additionally, the following are included in order to accomplish the goals of this project: A portion of Dr. Pence's time to closely direct the project and to conduct hormone assays; a portion of the time of one PCD Research Associate for cryopreservation work and of lab assistants (salaried and volunteer) for media making and routine transfers; a portion of the time of Dr. Brien Meilleur, for coordination of the CPC gardens; and a portion of the time of the garden staff for maintaining plants, and collecting and sending plant material to CREW. In addition to professional time, the project requires consumable supplies, including media, hormones, antibiotics, petri plates, culture tubes and caps, antibodies and chemicals for ELISAs, greenhouse supplies, etc. For dissemination of the results of this study, travel to one meeting of the Society for In Vitro Biology is included.

The request to IMLS is for $73,785, which is 39.6% of the total budget for completion of this project. IMLS funds will be used to underwite the salary and fringe benefits of a full-time Research Assistant for two years; a portion of Dr. Brien Meilleur's salary; a portion of the garden staff salaries; a portion of the supplies; and travel to the SWB meetings in 2001.

8. What are the qualifications of the project personnel?

Valerie C. Pence, Ph.D., Head, Plant Conservation Division
Cincinnati Zoo and Botanical Garden
Center for Research of Endangered Wildlife
Dr. Pence earned her Ph.D. in Plant Physiology from Northwestern University and conducted her Postdoctoral research at Purdue University and the University of Florida. As the Head of the Plant Conservation Division of the Cincinnati Zoo and Botanical Garden Center for Research of Endangered Wildlife (CREW) since its formation in 1986, she is a leader in the development of technologies for the preservation and propagation of rare and endangered plant species. All of her doctoral and post-doctoral research has involved tissue culture systems. In addition to her position at CREW, Dr. Pence is an Adjunct Research Associate Professor in the Department of Biological Sciences at the University of Cincinnati. As a member of the Scientific Advisory Council of the Center for Plant Conservation (CPC), she provides scientific guidance for the preservation and propagation of the species held as part of the organization's National Collection of Endangered Plants. Dr. Pence will direct the project and work closely with the Research Assistant and other CREW staff to design

and modify protocols for each of the species, monitor their progress, and analyze and disseminate the results of this work. She also has extensive experience in the use of ELISA for measuring plant hormones and will conduct the hormone assays for this project.

Brien A. Meilleur, Ph.D., President and Executive Director
Center of Plant Conservation
Missouri Botanical Garden
Dr. Meilleur received his Ph.D. in Anthropology from the University of Washington. He has held numerous research positions in the United States and France. As the President and Executive Director and former Board Member of the CPC, he has extensive experience with and knowledge of plant conservation. He is in direct contact with the staffs and collections of the twenty-eight botanical gardens and arboreta throughout the United States, and therefore is well-positioned to form collaborations for the preservation of endangered plant species. Dr. Meffleur is a member of the Plant Conservation subcommittee of the Species Survival Commission of the IUCN-The World Conservation Union and the current Secretary/Treasurer of the Society of Ethnobiology. He is also a member of the Affiliate Graduate Faculty in the Department of Anthropology at the University of Hawai'i at Manoa, Honolulu, HI. While in his previous position as director of the Amy B. H. Greenwell Ethnobotanical Garden in Captain Cook, Hawai'i, he secured funds to create and annually support a research program in Hawaiian ethnobotany, and to build a modern propagation facility, among other accomplishments. Dr. Meilleur will act as a coordinator between CREW and the CPC-gardens, review the results of the research and advise on aspects of the conservation strategies for the species being addressed through this project.

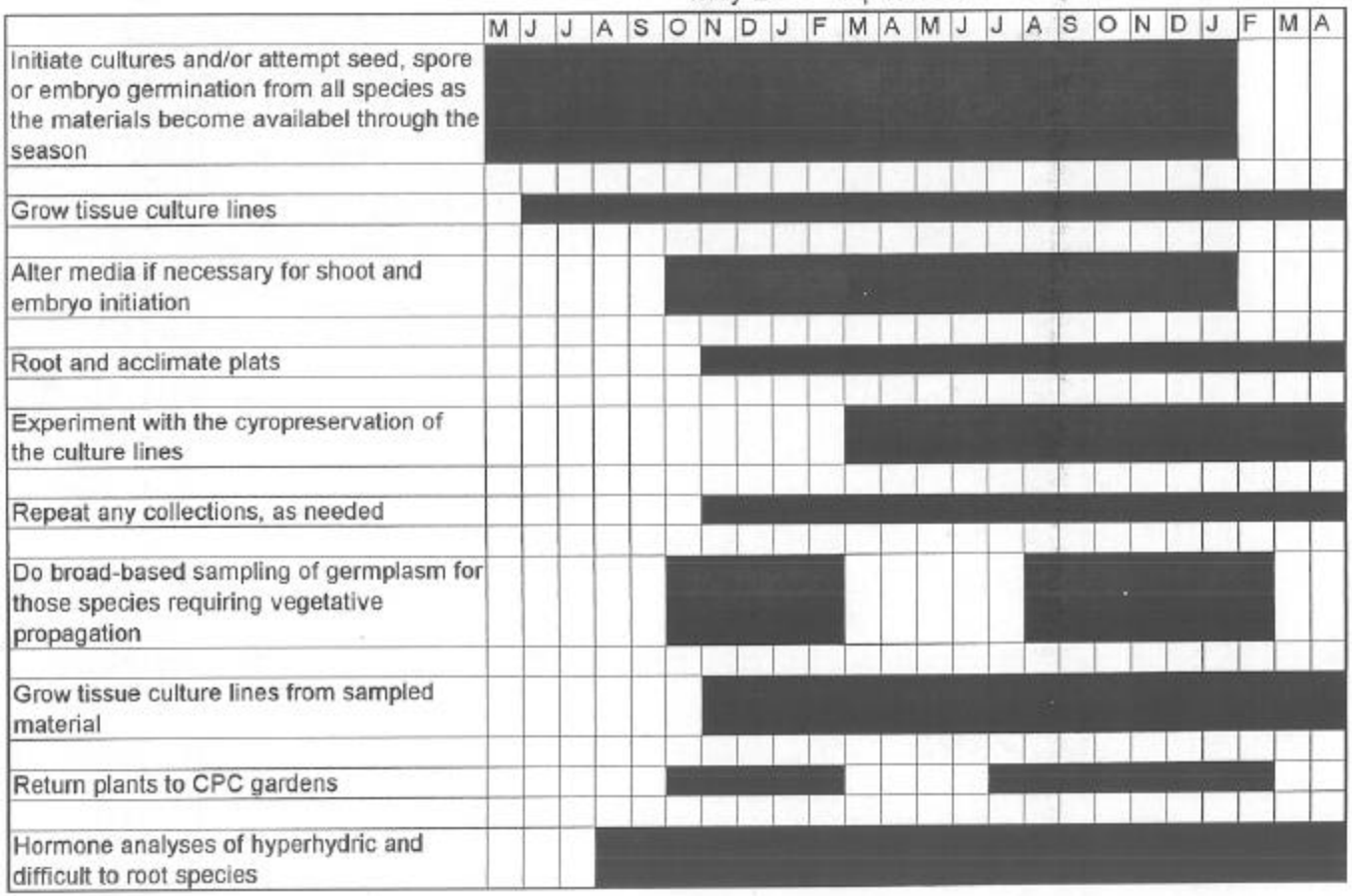
Full-time Research Assistant, John Clark
Mr. John Clark is working on the propagation of the endangered species under the current IMLS funding. Mr. Clark received a B.S. in Biological Sciences from the University of Cincinnati in August of 1996 and will complete his M.S. there in the spring of 2000. He has worked with CREW since September of 1996 where he has gained expertise in several types of tissue culture. His responsibilities are centered entirely on the plants included in the IMLS project. If funding is received for the proposed project, it is expected that he will continue in this position.

CREW Research Associate, Bernadette Plair
Ms. Bernadette Plair, CREW PCD Research Associate will assist with this project with 20% of her time. Ms. Plair has had experience with a variety of tissue culture systems and has worked extensively with the cryopreservation of a variety of plant tissues, including IMLS funded species. She has also worked with the in vitro collection project in the PCD. She completed her Masters' Degree from the Department of Biological Sciences at the University of Cincinnati in the summer of 1998.

Laboratory Assistants
Several workers will fill this position part-time, including one salaried worker and several volunteers who work in the PCD on a regular basis. These LAs routinely make tissue culture media, make routine tissue culture transfers, assist in greenhouse work and wash glassware.

Schedule of Completion

May 2000 - April 2002



Project Budget Form

SECTION 3: SUMMARY BUDGET - CP AND EDUCATION COMPONENT

Name of Applicant: Cincinnati Zoo and Botanical Garden

DIRECT COSTS

	IMLS	MATCH	TOTAL
SALARIES AND WAGES (PERMANENT STAFF)	$ 9,410	46,310	55,720
SALARIES AND WAGES (TEMPORARY STAFF HIRED FOR PROJECT)	46,750	6,822	53,572
FRINGE BENEFITS	14,025	17,740	31,765
CONSULTANT FEES			
TRAVEL : DOMESTIC FOREIGN	1,100		1,100
SUPPLIES & MATERIALS	2,500	4,500	7,000
SERVICES			
OTHER			
TOTAL DIRECT COSTS	$73,785	$75,372	$149,157
INDIRECT COSTS	$18,446	$18,843	$37,289
TOTAL PROJECT COSTS			$186,446

AMOUNT OF CASH - MATCH $ 75,372

AMOUNT OF IN - KIND CONTRIBUTION MATCH $18,843

TOTAL AMOUNT OF MATCH (CASH AND IN - KIND CONTRIBUTIONS) $94,215

AMOUNT REQUESTED FROM IMLS $73,785

PERCENTAGE OF TOTAL PROJECT COSTS REQUESTED FROM IMLS (MAY NOT EXCEED 50%) 40 %

Have you received or requested funds for any of these project activities from another Federal agency? NO

1. WHAT IS THE DESIGN OF THE PROJECT?

Although many environmental factors have an impact on growth and survivorship of the Karner blue butterfly (KBB), our study will center on the roles of relative humidity (RH) and temperature (T) in synchronizing development of captive-born larvae and improving the survivorship of adults and overwintering 2nd brood eggs. This research will seek to identify conditions of T and RH that will: 1. Increase hatching success of overwintering 2nd flight KBB eggs in captivity; 2. Allow KBB larval development to be synchronized in order to maximize mating opportunities for adults; 3. Increase longevity of adult KBBs in captivity. Experimental design, set-ups, and project supervision will be the primary responsibility of the Project Director, Peter J. Tolson, Ph.D., Conservation Biologist and Research Coordinator for the Toledo Zoological Gardens (TZG). Tolson will devote 12.5% of his total work effort/yr. specifically to this project; a total of 25% of work effort/yr. will be devoted to KBB activities over the duration of the project. The Coinvestigator in this project will be Mitchell L. Magdich, B.S. Curator of Education for the TZG. Magdich will aid in supervision and implementation of this project, especially when Tolson is not present. Magdich will devote 9% of his total work effort/yr. specifically to this project; a total of 18% of work effort/yr. will be devoted to KBB activities over the duration of the project. Candee L. Monak, B.A., will assume the duties of KBB Research Technician. She will be responsible for maintenance and manipulation of experimental and control group KBBs as well as care of host and nectaring plants. She will devote 50% of her total work effort/yr. specifically to this project. An additional 50% of work effort/yr. will be devoted to other KBB recovery activities over the duration of the project. Monak will carry out all experimental tasks under the supervision of Tolson and Magdich, who will aid with activities as needed.

Task 1: Collection of winter environmental data at KBB oviposition sites. These data will be collected from three sites in the Allegan State Game Area (ASGA), Allegan County, Michigan, from which founders of the captive population were collected: "42nd Street, "Gun Club" and "Monroe Rd." Assessment of environmental conditions of overwintering eggs in the wild will be made by placement of data loggers at oviposition sites of the KBB in the ASGA. Temperature and RH at duff level will be collected using Stowaway® 32K data loggers programmed to record at 30-mm. intervals. Data will be collected continuously from Oct-Apr. 1999, downloaded monthly, and used as control values for T and RH in task 4. This activity will require 1 round trip of 415 mi./month to the ASGA. As this task requires travel from the Zoo, Tolson, Magdich and Monak will share responsibility for this task.

Task 2: Determination of non-lethal cooling periods to synchronize larvae. Oviposition by wild and captive KBB females typically spans a three-week period (1). Thus, individuals hatched from eggs oviposited early in the season metamorphose three weeks before individuals from the late hatches. In order to maximize opportunities for mating in captivity it would be advantageous to have metamorphosis synchronized so that maximum numbers of adults emerge within 1-3 days of each other. As cooling will retard metamorphosis, we intend to test whether cooling can be used as a tool to synchronize emergence. Two groups of ten 4 instar KBB larvae will be cooled slowly to 50 and 100 C, respectively, for one week on potted lupine plants housed in Percival® E-36 plant growth chambers (in cool weather larvae will normally burrow in the soil at the base of the plant). Larvae will be monitored daily. Total time from oviposition to metamorphosis and any mortality will be quantified. If survival exceeds 75%, larvae will be cooled for an additional week and results quantified as before. Survivors will be returned to the colony and allowed to metamorphose. This study will take place from April- July in 2000 and will utilize both 1st and 2nd flight larvae. If mortality is < 10%, this activity will be repeated as needed in Apnl-July 2001 to synchronize metamorphosis for breeding.

Task 3: Determination of effects of larval cooling on sex ratios.
In the wild male KBBs typically appear several days before females. This experiment will determine if cooling of late instar larvae has any effect on an expected 1:1 sex ratio.

KBBs are sexually dimorphic and are easily sexed. In this simple experiment sex ratios will be quantified by counting relative numbers of males and females produced from 4th instar larvae cooled in experiment 2 and will be conducted concurrently.

Task 4: Effects of fogging on longevity of adult XBBs in captivity.
Wild KBBs generally live no longer than 5-7 days in the wild (2), where they are exposed to huge fluctuations in temperature and humidity (3). However, at the TZG, KBB females have lived as long as 26 days. We have documented that adult KBB mortality in captivity is higher in periods of extreme heat (4). We will maintain a control group of 25 newly

metamorphosed KBBs without fogging and compare their longevity with a experimental group provided with a Ecologic Technologies Rainmaker I fogging system designed to activate for 5 min. at intervals of 30 mm. when temp. exceeds 90° F. in the propagation facility. Both groups will be housed m 236 x 137 x 86 cm Bioquip® TropicScreen II mesh enclosures. The total numbers of adults produced will determine the size of the experimental group; it will at least equal the number in the control group. Stowaway® 32K data loggers programmed to record at 30-min. intervals will be used to record T and RH in both control and experimental groups. Monak will carry out this experiment on flight adults in late June-August 2000.

Task 5: effects of RH on hatching success of 2nd brood KBB eggs.
After the first season of over-winter environmental data are collected at the AS GA, 250 KBB eggs from the 2nd brood will be collected after oviposition and will be divided into three experimental groups of 25 eggs each and one control group of 25 eggs. The control group will be transported to Allegan, Michigan in mesh-covered pots with lupine duff and maintained at the ambient winter temperatures and RH of the ASGA in a protected area outdoors. The experimental groups will be maintained in Toledo in Percival® E-36 thermostatically controlled plant growth chambers at 5° C at three different RHs. The first group will be maintained at a constant RH 5% higher than the average fall! winter RH at the ASGA. The second group will be maintained at a constant RH 5% lower than the ambient fall! winter RH at the ASGA. The third group will be maintained at 0 RH by placement in sealed pots with a vapor-proof covering. Temperature of experimental groups will be maintained at the ambient winter Ts of the ASGA. Diurnal-nocturnal fluctuations will be programmed into the environmental chambers. Hatching success will be recorded in all four groups and evaluated statistically. Monak will carry out this task from October 00-April 01.

Task 6. Effects of food quality on 3rd-flight induction of KBBs. This final experiment will test the hypothesis that host plant quality may determine hatching, or lack thereof, on 2nd brood KBB eggs. We observed that three (rather than the usual two) flights of Melissa blue butterflies could be induced in captivity. In contrast to 2nd flight KBB females, which were forced (by design) to oviposit on senesced lupine, the 2nd flight Melissa blues had access to host plants *(Astragalus canadiensis*- another legume) with lush growth.
Goodpasture (5) noted that female *Plejebus* (another Lycaenid species of blue) preferentially select host plants, which bad been fortified with nitrogen for oviposition-so host plant quality is important for oviposition in at least one species of blue. This experiment would restrict experimental females to non-senesced lupine (=good foliage) for oviposition of their eggs. The control group would have females restricted to senesced (=dried foliage) host plants for egg laying. Number of 2nd brood eggs hatching would be quantified in each group and statistically compared. This activity would take place in July-September 2000.

Our schedule of completion is particularly appropriate for this research because it is based on the natural cycles of the KBB in the wild. Collection of environmental data in the field is necessary to establish baseline values for further experimentation; thus this task will be accomplished first. Experiments will be performed concurrently when possible. The appearance of different forms in the life cycle, i.e. eggs, larvae, pupae, and adults will dictate the timing of subsequent separate experiments. After data have been collected, the husbandry manual will be written.

The research facilities housing KBBs will include a 35’ x 45’ polyhouse and adjacent
indoor conservation facilities on the TZG grounds. Facilities are protected from disruption by 8’ penmeter chain link fencing and 24-hr. security. There is no public access to this site. Butterflies are protected from spiders and other predators by netting over each individual pot housing eggs, larvae, pupae, or adults. All pots are checked
every two days for insect health, plant rotation, and removal of any potential predators.

2. WHAT IS THE OBJECT(S) HISTORIC STRUCTURE(S), OR SPECIMEN(S) THAT IS THE FOCUS OF THIS PROJECT?

The object of this research is the Endangered Karner blue butterfly, *Lycaeides melissa samuelis,* which has suffered catastrophic population declines in the U.S. over the past decade. The KBB has declined by 99% or greater over its range in the past 100 years (6); an IUCN PHVA (7) estimated that 90% of this decline has occurred in the past 10-15 years. Within this period the KBB has been extirpated from Illinois, Massachusetts, Ohio, Ontario, and Pennsylvania. Fewer than 20 individuals were counted last year in New Hampshire. The KBB is a signature species of the extremely rare oak savanna ecosystem, a globally endangered habitat characterized by meadows of prairie plants dispersed among stands of widely spaced oak trees. Oak savanna in Ohio is limited to a small region of Northwest Ohio known as the Oak Openings, which has special relevance to the State of Ohio because it contains more endangered species than any other region of the state. It was the last area in Ohio where the KBB was observed (8,9). The region, as well as the KBB, has national significance, and the TZG dedication to restore the KBB to Ohio is shared by a powerful coalition of conservation partners in this project, which includes the U.S. Fish and Wildlife Service (USFWS), the Ohio Department of Natural Resources (ODNR), The Nature Conservancy, and the Terrestrial Invertebrate TAG (TITAG) of the AZA. This is a priority project under the 3-year Collection/Action Plan of the TITAG and the AZA North American Conservation Action Partnership.

The conservation of the flora and fauna of the Oak Openings of Lucas County is our highest conservation priority and particularly well suited to our mission, which is “.. .to promote wildlife and its conservation through excellence in animal

management, educational programs, and scientific activities..." Oak savanna butterflies, especially the KBB, are a significant part of our institutional identity with our public and our peers. The Oak Openings region and its flora and fauna are extremely popular with the residents of Lucas County. We have a permanent museum exhibit in the TZG Museum of Science on this region and extensive educational outreach programming to local schools about the Oak Openings. Butterflies, especially Lycaenids, have very high public appeal. As New (10) noted "... it is no exaggeration to claim that they have been the most important butterfly family in fostermg conservation concern in temperate regions." Specifically, the KBB "... takes rank with the condor, orangutan, and wolf as a symbol of endangered species." (11), yet relatively few zoos allocate resources to recovery of endangered insects. In response to these conservation concerns twenty-six 1st flight adult female KBBs were collected by TZG staff from the ASGA in Allegan, Michigan in 1998 for conservation breeding. From these individuals, 592 eggs were oviposited, producing 172.l67.2 adults. We retained 84.93 adults from the 2 flight for breeding. These females produced 182 eggs, which are overwintering in the TZG butterfly facility. KBBs do not survive the winter as adults.

3. HOW DOES THE PROJECT RELATE TO YOUR MUSEUMS ONGOING CONSERVATION ACTIVITIES?

Our Conservation Master Plan emphasizes that "New conservation programs will be developed to serve local conservation priorities for both plants and animals..." We believe that we have a special responsibility for the conservation of animals and plants of our local community. Development of a captive-breeding program for the KBB has been one of our top conservation priorities since 1992, when we embarked upon a comprehensive program for the conservation of the lupine-dependent butterflies of the Oak Openings. Our efforts began with a project in 1992 to develop propagation and management techniques for the wild lupine, *Lupinus perennis,* the obligate host plant for the KBB as well as the state Endangered Persius dusky wing, *Erynnis persius,* and the frosted elfin, *incisalia irus.* This project, funded by the ODNR Division of Natural Areas and Preserves, was successful and has led to the annual cultivation of more than 5,000 lupine plants at the TZG butterfly propagation facility. In 1995, after large-scale lupine production, was mastered, captive propagation with a model taxon- the Melissa blue *(Lycaeides m. melissa)* was initiated. These butterflies were successfully bred and over-wintered through the complete bivoltine life cycle at the TZG in 1995-96. This was the first captive breeding of this species in any facility. We applied for Federal and State (Michigan and Ohio) permits for collection of wild KBBs in 1997; these were obtained in early 1998. In May of 1998, 26 wild KBBs were collected for conservation breeding. Their offspring successfully bred at the TZG. This was the first captive breeding of this endangered subspecies. The Oak Openings project has since expanded to the point where it incorporates employees from several different departments (including the keeper staff) in monitoring and research programs for the American badger, lark sparrow, and local frogs. Approximately 40% of total research efforts of the Project Director are devoted to Oak Openings programs, more than any other single project.

Our work with oak savanna butterflies, and the subsequent re-introduction of the KBB to the Oak Openings, follows a string of TZG conservation successes for U.S. Endangered Species. These included a comprehensive program of captive breeding, recovery, and reintroduction for the Endangered Virgin Islands boa and led to the successful reintroduction of the boa to Puerto Rico in 1993- the first reintroduction of an SSP reptile species. IMS support played a pivotal role in the implementation of this program (IMS Cons Grants IC-70095-87, IC-90453-89). IMS-sponsored research has led to publication of numerous research papers and a book by the Project Director. In fact, the TZG has won national recognition for its conservation programs with three AZA Conservation Awards in the past four years. Despite these successes, research on KBB husbandry remains our most critical conservation need. We are alarmed at the low survival and egg production of 2nd flight KBB females in our facility. In contrast to the 593 eggs produced by wild-caught females, 93 captive born females produced only 182 eggs. We believe that low egg production can be attributed to two main factors- poor longevity (females died before copulation or oviposition could occur) or poor fertility (limited male-female encounters). This proposal addresses these problems, which must be solved if long-term viability of the KBB in our collection is to be assured.

4. WHAT ARE THE ANTICIPATED BENEFITS OF THIS PROJECT?

Acquisition of these data will solve immediate, critical problems in the reproductive management of our butterfly collection. Determining optimal microhabitat conditions for adult butterflies, larvae, and eggs will result in greater numbers of eggs laid, as female longevity directly translates into increased egg production. The most direct benefit will be an increase in numbers of the KBB in our collection. This in turn will increase the demographic stability and increase the probability of the long-term survival of the KEB in captivity. These data are critical. As Ding (1) has noted "Since the entire reproductive potential of the butterfly is held in its overwintering eggs, a thorough understanding of this period is critical to preservation attempts." This information would benefit many other institutions that wish to initiate KBB conservation breeding programs. In fact, we are being viewed as a model program for other states wishing to augment their KBB populations (pers. comm. B. Fazio, USFWS). In addition to developing techniques for assuring the long-term viability of the captive KBB collection, we will produce a comprehensive husbandry manual for the KBB, which will be made available to other institutions to breed KBBs in captivity. The results of our research will be published in peer reviewed journals and

presented at scientific meetings. In the future, results from this research can be used to augment the numerous precarious populations of the KBB in the wild, on to restore the KBB to other states from which it has been extirpated, such as Illinois. Our landscape management efforts for the KBB in the wild, undertaken in partnership with The Nature Conservancy, include direct participation in restoration and replanting of habitat for the KBB and other butterflies. Lupine and nectar plants are grown at the TZG for this purpose. These activities benefit other species of the Oak Openings, such as the aforementioned American badger and the lark sparrow.

5. HOW WILL THE APPLICANT ENSURE THAT ONGOING MUSEUM FUNCTIONS ARE NOT INHIBITED BY THESE PROJECT ACTIVITIES?

Financial Resources: The required institutional contribution will not negatively affect our other operations. Funding for conservation project support is included each year in the budget of the Conservation Department. Revenues have significantly increased each year for the past five years and are currently at record levels for our zoo- over 1 million visitors in 1998! Our direct mail appeal, the Animal Rescue and Conservation Fund, has resulted in additional revenue for conservation activities, allowing us to increase our commitment to conservation projects in each of the past five years. A significant cash match provided by the ODNR will augment TZG and IMLS funding of the project.

Human resources: Conservation excellence at a small Zoo such as ours demands that all departments share in relevant activities. Therefore, *in situ* conservation activities are embraced as a normal part of our institutional responsibilities. Since 1992, both the Project Director and the Co-investigator have devoted summer conservation activities to oak savanna butterflies almost exclusively. The Education Curator, the 'co-investigator, will aid in supervision of this project during any absences of the Project Director, so there will be minimal impact on other conservation projects. A Research Technician hired specifically for the project will conduct experimental manipulations, monitor, and provide care for the experimental insect groups. We have designed this research so that a number of experiments can be performed concurrently, thus saving technician time. We have designed the research plan so that one member of the research team will always be on grounds or available when travel away from the facility is necessary.

6. WHAT ARE THE PROPOSED CONSERVATION METHODS AND WHY ARE THEY CONSERVATIONALLY SOUND?

Plans for conservation breeding projects should include a determination of the environmental conditions faced by the target species in the wild. This most simply and reliably accomplished with Onset Computer Corp's Stowaway® data loggers. The 32K loggers can collect data at 30-mm. intervals for 677 days without additional programming and have a battery life of ca. 3 years. They are unquestionably the most efficient and reliable way to collect our environmental data. With funding from the ODNR, we collected two years of spring-summer environmental data during the flight periods of the KBB at the ASGA that allowed us to be the first institution to successfully breed the KBB in captivity (2). In contrast to previous labor-intensive efforts to lab-rear KBB larvae (12,13), we have proven that it is both possible and practical to mass-rear hundreds of KBBs for release or captive breeding. Our approach is novel, housing pairs or groups of reproductive butterflies or larvae in individual pots containing living lupine, nectar plants, and an artificial nectar source. These techniques were developed in consultation with the USFWS and ODNR KBB Recovery Teams. However, we need to fine-tune our operation, and this research is a logical starting point for determining optimal conditions for winter maintenance of KBB eggs and maximizing reproductive opportunities for adults. The experimental approach we have taken is the best way to determine which environmental variables are important in increasing survival of eggs, larvae, and adults.

We have used our experience in the field and with captive KBBs to determine which factors in survival are worthy of further study. For example, we know that low temperatures delay maturation of butterfly larvae, and we also know that our Melissa blue butterflies over-wintered as $_4$th instar larvae. This leads us to believe that we can cool KBB larvae to synchronize metamorphosis without excessive mortality. Plant growth chambers are the most efficient and reliable way to maintain experimental conditions within the target ranges for both eggs and larvae.

7. H0W DOES THE PROJECT BUDGET SUPPORT THE GOALS AND OBJECTIVES?

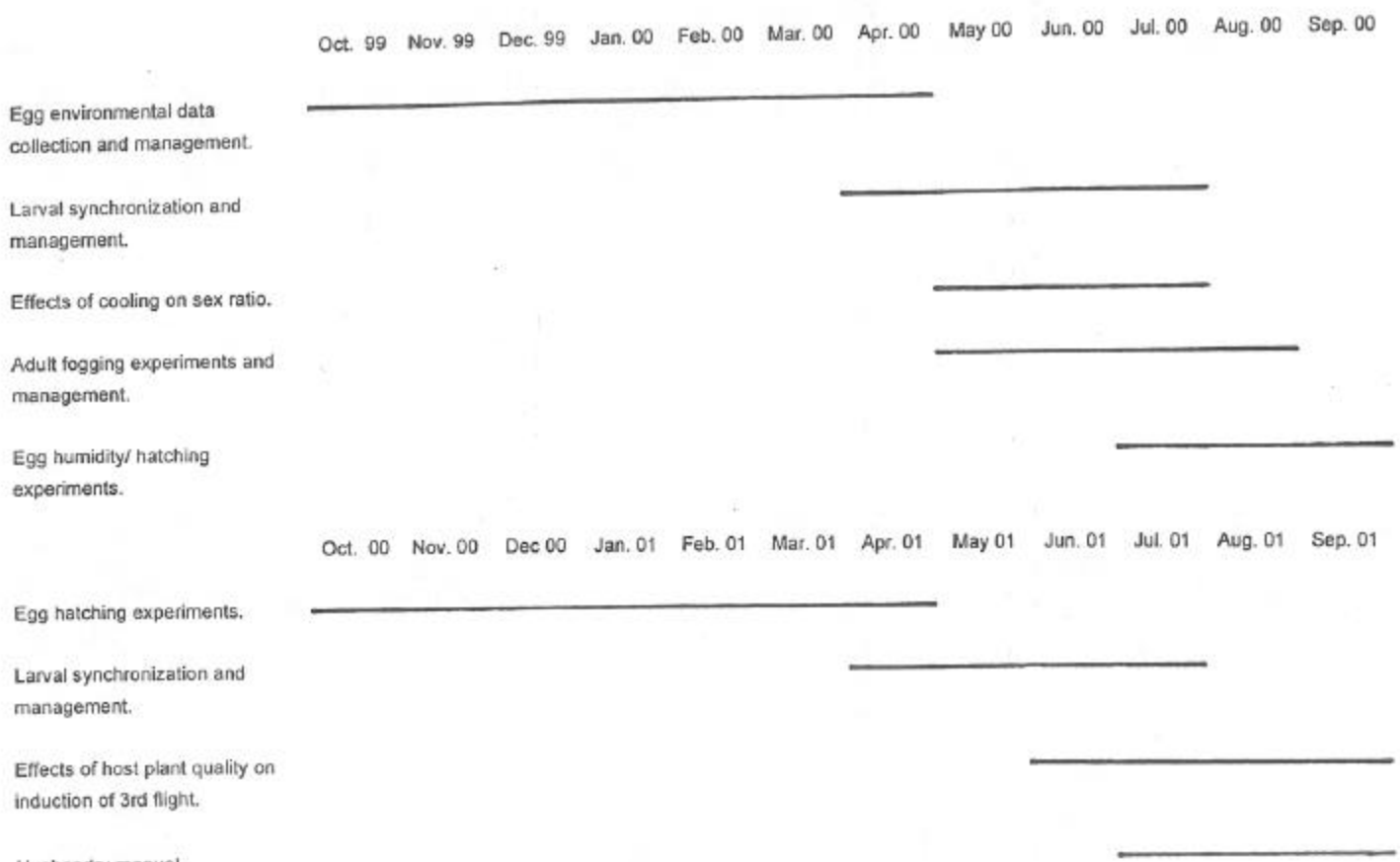
The budget was developed from our extensive experience of environmental and propagation research for butterflies and lupine from 1992- present. The equipment we selected gives excellent value for the money without sacrifice of either precision or reliability. We elected to use smaller plant growth chambers than expensive environmental rooms that cost 5x as much. Plant growth chambers were selected rather than less expensive incubators because of our need to maintain precise ranges of humidity coupled with the ability to support plant growth. Similarly, the Ecologic Technologies

Rainmaker® system was chosen as a more cost- effective alternative to more expensive foggers, such as the Mee® system. Our equipment was selected by direct quotes from manufacturers for quality, reliability, and cost-effectiveness. In all cases, we attempted to be as frugal as possible without jeopardizing experimental design and quality. The position of technician is justified by our critical need for close monitoring of equipment and KBBs during the course of this study. Our technician wages rates were developed in consultation with the USFWS and the ODNR, who will provide the cash match to fund this position. We have designated this position as hourly so we can schedule Monak according to research needs. We will use the services of a Research Fellow to aid the Research Technician in the summer when work load will be the highest.

8. WHAT ARE THE QUALIFICATIONS OF THE PROJECT PERSONNEL?

The project will utilize the skills of Dr. Peter J. Tolson, TZG Conservation Biologist, Mitchell L. Magdich, TZG Curator of Education, Candee L. Monak, and a Roger Conant Research Fellow. Experimental design, project supervision, and initial equipment set-up will be the primary responsibility of Tolson, who will also help implement the project when needed. Magdich will aid in supervision and implementation of this project, especially when Tolson is not present. Monak will be responsible for maintenance and manipulation of experimental and control group KBBs as well as care of host and nectaring plants and equipment. All participants have experience with environmental chambers, misting systems, and loggers from previous projects. The Research Fellow will aid Monak in care for experimental subjects and maintaining the research facilities. Tolson and Magdich have a long history of successful fieldwork with endangered species and were awarded the 1998 Conservation Colleague Award by the Ohio Chapter of The Nature Conservancy for their work with the KBB. Their efforts led to the TZG becoming the first institution to breed both the Melissa blue butterfly and the KBB. Magdich has an intimate knowledge of the butterfly and plant communities of the Oak Openings and has long been associated with the ODNR Division of Natural Areas and Preserves as a result of his surveys for the KBB and the wild lupine. Tolson is best known with his work with West Indian boas, for which he has won both the AZA Bean Award and the AZA Conservation Awards for the TZG. For the past seven years be has worked with Magdich on monitoring and recovery of oak savanna butterflies in the Oak Openings. The Toledo Zoo hired Candee L. Monak in 1998 as a part—time KBB Coordinator. She was instrumental in the supervision of three research fellows in the propagation and husbandry of lupine and KBBs at each stage of the life cycle and was intimately involved in the monitoring of released KBBs at the Kitty Todd Preserve.

Schedule of Completion



Project Budget Form

SECTION 3: SUMMARY BUDGET - CP AND EDUCATION COMPONENT

Name of Applicant Toledo Zoological Gardens

IMPORTANT! READ INSTRUCTIONS IN PART 4 BEFORE PROCEEDING.

DIRECT COSTS	IMLS	MATCH	TOTAL
SALARIES AND WAGES (PERMANENT STAFF)		$14,940	$14,940
SALARIES AND WAGES (TEMPORARY STAFF HIRED FOR PROJECT)	$21,000	$24,000	$45,000
FRINGE BENEFITS		$ 4,034	$ 4,034
CONSULTANT FEES			
TRAVEL: DOMESTIC	$ 1,154		$ 1,154
FOREIGN			
SUPPLIES & MATERIALS	$16,335		$16,335
SERVICES			
OTHER			
TOTAL DIRECT COSTS	$38,489	$ 42,974	$ 81,463
INDIRECT COSTS*	$	$ 4,297	$ 4,297

* *If you do not have a current Federally negotiated rate, your indirect costs must appear in the Match column only.*

TOTAL PROJECT COSTS		$85,760
AMOUNT OF CASH—MATCH	$21,000	
AMOUNT OF IN-KIND CONTRIBUTIONS—MATCH	$26,271	
TOTAL AMOUNT OF MATCH (CASH AND IN-KIND CONTRIBUTIONS)		$47,271
AMOUNT REQUESTED FROM IMLS		$38,489
PERCENTAGE OF TOTAL PROJECT COSTS REQUESTED FROM IMLS (MAY NOT EXCEED 50%)		44.9 %

Have you received or requested funds for any of these project activities from another Federal agency? *(please check one)* ☐ Yes ☒ No

If yes, name of agency _____ Date _____

Amount requested $ _____

Chicago Zoological Society
Illinois
Environmental

1. WHAT IS THE DESIGN OF THE PROJECT?

Introduction: The purpose of this project is to test a Brookfield Zoo design modification of an algal turf scrubber developed at the Smithsonian institution's Marine Systems Laboratory in order to maintain and conserve healthy aquatic animals in our collection. This project has two goals:

1) Optimize algae growth rate and algal scrubber efficiency off-line.
2) Install and run the optimized algal turf scrubber in-line in an exhibit system.

Background: Brookfield Zoo's *Living Coast* aquarium facility was first opened to the public in April, 1997. It exhibits a large variety of South American aquatic animals found in the temperate waters (mean temperature of 18° C) off the coasts of Peru and Chile from moon jellyfish to green sea turtles and Humboldt penguins. Its five marine exhibits total 344,890 liters of artificial seawater. After one year of operation, its largest marine system, (197,080 liters) *Near Shore Waters* (NSW-see photos 1 - 2), currently filtered by two 8-foot high-pressure horizontal sand filters and ozone (see photos 4—5), showed a high accumulation of nitrite plus and nitrate ($N0_2$-N + $N0_3$-N = 50 mg/L) and phosphate (total-$P0_4$= 6 mg/L). Since then, these nutrient levels have continued to climb in all of the Living Coast systems. The high nutrient levels we have in our marine exhibits are typical in our industry for closed recirculating systems without algal turf scrubbing.

The Smithsonian's algal turf scrubber design evolved through a series of prototypes of coral reef ecosystem models (Walton, 1980; Adey, 1983). Dr. Adey will be the consultant on this project. It was designed to produce elevated rates of plant production in order to remove a large quantity of natural products in model ecosystems for research. These algal turf scrubbers have been used by researchers and associates of the Smithsonian's Marine Systems Laboratory for over 100 years of operation with astonishingly positive results. They have maintained nitrate and phosphate levels in the PPB range for temperate and tropical marine research systems, as well as in a model freshwater sewage treatment system (see, e.g., Adey and Loveland, 1998; Adey, 1995; Adey, 1983; Luckett *etal.*, 1996).

Of particular interest to us is the demonstrated ability of these scrubbers to maintain nitrite plus nitrate nitrogen at less than 0.002 mg/L in systems like The Great Barrier Reef Wonderland Aquarium in Townsville, Australia (Jones, 1988). This system is similar to our target system, incorporating ozone and sand filtration with centrifugal pumps in a public aquarium with a high animal density. Its algal turf scrubber operates at 0.3 square cm. of scrubber surface area per liter of aquarium water. These scrubbers take up a tremendous amount of space and are lit with natural sunlight.

Brookfield Zoo's algal turf scrubber was completed in-house from 3/98 - 3/99, with support from the combined efforts of our Welding, Life Support, Exhibits, and Animal Collection departments. The Smithsonian design was modified to compliment typical zoo and aquarium systems using ozone generators, impeller pumps, and sand filters and to reduce the space, lighting, and maintenance requirements of the system. The scrubber is called a rotating algal turf contractor (RATC).

The Smithsonian's shallow tray design requires considerable lighting surface area, floor space, and a large mechanical wave generator device to filter a sizable exhibit (see fig. 1). The Brookfield Zoo design uses a rotating cylinder contactor over a shallow trough of water with high intensity discharge (HID) metal halide lamps mounted directly overhead (see photos 6-8 and RATC video). This provides contact with over 1.5 square m. of culture screen using only 1 square m. of filtration floor space. Since the contactor rotates through the light path, only .3 square m. of the culture screen has to be lit by the HID lighting! This is compared to a floor space of 1.5 square m. and 1.5 square m. of lighting surface area needed for the original Smithsonian design. Only a microfilm of water is maintained on the algae minimizing the loss of light irradiation due to water penetration. The rotating action provides the needed "light flasher effect" and metabolite exchange that wave and surge actions produce over natural algal turfs in the wild -- boosting the efficiency of the photosynthetic mechanisms (Adey, 1987; Adey and Hackney, 1989; Adey *etal.*, 1993). This makes a wave generator mechanism unnecessary. Because of its compact design, we were able to find room for it in a small service room. When it is installed in-line, we believe we can eliminate the yellow-water effect by adjusting ozone treatment levels. The Columbus Zoo is conducting a parallel study with the Smithsonian design and has found ozone to be an effective treatment for clarifying algal turf contactor effluent (personal communication). Since this rotator design might not trap organic particulates as well

as the Smithsonian design, we have additional filters to do this.

To date, our investigations have produced solutions to a number of design issues (see fig. 2). We have developed a very reliable stainless steel axle with epoxy composite ceramic bearings for the RATC. Special foam ribs evenly spaced across the entire length of the contactor create an effective "paddle wheel" for turning it and also serve as an effective water dispersion mechanism as the influent from the system pump strikes it. Therefore, the RATC does not need to be submersed in water (reducing friction) and its rotation rate can be very easily adjusted by adjusting the pump flow rate. We use special 400-watt metal halide lamps for the RATC with a light temperature of 6500 ° K and a color rendering index of 92. At a distance of 18 inches and a day-cycle of 12 hours on and 12 hours off, this lighting regimen is very close to lighting found over many natural algal turf beds in temperate waters.

At this time, we are beginning to establish a flourishing algal bed on the contactor screen at the midpoint rotation rate of 60 RPM. An algal turf is a dynamic community of algae, containing up to 40 different species/m^2 of substrate. It will be seeded with 10 Kg of turf substrate from Pacific Ocean temperate waters, the taking of which will not harm the natural Pacific community. Dominant species of algae in a temperate Smithsonian system were *Ectocurpus, Enteromorpha Cladophora, Polysiphonia, and Porphyra.* Blue-greens and diatoms were also present within the dense algal turf. Its mean production level was 12.0 g (dry wt) / m^2 / day (Adey and Loveland, 1998).

During approximately the same time period in which we developed the RATC design, the Columbus Zoo has been operating a Smithsonian-style algal turf contactor with an algal turf surface area of 2 m^2. They have been using it for batch treatments on a 18,950-liter algal treatment basin on water from a 379,000-liter marine fish exhibit with water quality parameters very-similar to ours. They have been able to reduce PO_4 levels from 20 mg/L to as low as 0.1 mg/L and nitrate nitrogen levels from 50 mg/L to as low as 0.1 mg/L. They are participating in this project with us to more accurately quantify their results and compare them to ours.

Project Design: When the study commences, we have two goals to test, optimize, and implement the design in our exhibit system. Details to accomplish each goal follow.

Goal 1 (10/1/99 - 9/30/00): Determine optimal rotation rates to achieve algae growth rates of >=12.0 g algae dry wt / m^2 of culture screen, with the RATC off-line using batch treatments of NSW water. While varying the rotation rates, all other critical variables (lighting, water volume, temperature, etc.) are held constant. Measure nitrite plus nitrate nitrogen and phosphate concentrations to quantify the efficiency of the RATC process to remove the algal nutrients.

Throughout the entire study period, the RATC will have an attached environmental monitoring system (EMS) with data logger and sensors monitoring temperature, pH, oxidation/reduction potential, dissolved oxygen, RATC rotation rate, lighting irradiation, and system flow rate. These data will be automatically downloaded to a spreadsheet in the Water Quality Laboratory's (WQL) main computer via a phone modem. Maintenance of the EMS will entail the checking, cleaning, and calibrating of all sensors twice a month. *The EMS data will be important to document with a data logger since these are all critical performance parameters which could have a direct effect on the operational efficiency of the RATC should they change over time.* Other miscellaneous project maintenance tasks that will take place during the entire study period include the weekly siphoning of decomposing organic matter from the tub and tank, daily topping off the system with distilled water for evaporative loss and maintenance of the RATC work area.

Goal 1 will be achieved in the first year of this project and involves the regular batch treatment (568-liter batches) of NSW water using our RATC filtration component. Water will be circulated from a 568-liter reservoir tank over the contactor at a rate of approximately 200 liters per minute. In this temperate water system, the reservoir tank is equipped with a chiller to maintain the system at a constant temperature of 18°C. The contactor will be lit by two HID metal halide lamps with a color rendering index of 92 having a total of 1600 W / m^2 (to achieve an irradiance equal to 1500 p.E/m^2/sec) on a 12 hour on to 12 hour off daily cycle. The lights will be mounted 18 inches above the RATC (similar to artificial lighting used on Smithsonian systems).

From 10/1/99- 10/31/99, the RATC will be run at 60 RPM by adjusting pump flow rate accordingly using a tachometer. Algae will be harvested every two weeks into a catch tray using a tool similar to an automobile windshield scraper. The harvested algae will be dried in a mechanical convection oven at 80° C to constant weight and weighed on a Denver Instruments precision balance to determine dry weight of algae produced in 14 days at a RATC rotation rate of 60 RPM. From 11/1/99 - 11/30/99 the above procedure will be repeated with a RATC rotation rate of 30 RPM, and from 12/1/99 -

12/31/99 it will be repeated with a RATC rotation rate of 90 RPM. Beginning on 1/1/00, we will have determined the

best RATC rotation rate in terms of maximum algae production, and will set the RATC to maintain it as a constant rotation rate.

From 1/1/00 - 12/31/00, regular monitoring of the contactor's effect on the reduction of nitrite plus nitrate nitrogen and phosphate concentrations will be conducted. Samples will be collected three times per week for the in-house testing of $P0_4$-P concentration. Water samples will also be collected and preserved three times per week for analytical testing of $N0_2$-N + $N0_3$-N concentration. Preserved samples will be taken to the Shedd Aquarium Laboratory by the project's Water Quality Technician to assist the Shedd Chemist in the analysis of $N0_2$-N + $N0_3$-N twice per month. Results will be E-mailed biweekly to the Brookfield Zoo's Water Quality Laboratory.

From 1/1/00 - 12/31/00 dumping and filling the RATC system with NSW water will take place when target levels of nutrients are reached (phosphate and nitrite plus nitrate nitrogen = 0.03 - 0.05 mg/L) estimated to be every two weeks. At the same time the algae growing screens will be removed from the R.ATC for harvesting into a drying oven collection tray and reattached. Fresh samples of harvested algae will be sent to Dr. Adey for algae identifications monthly to document our turf community make-up throughout the entire study period.

All of the same water quality parameters we monitor will be monitored for comparison by the Columbus Zoo project personnel on their algal turf system, which will be operated according to Smithsonian protocol without altering any study - variables. It will be e-mailed biweekly to Brookfield Zoo's WQL. All project data from Brookfield Zoo's study and Columbus Zoo's study will be analyzed, compared, and interpreted biweekly. Monthly reports will be prepared and disseminated to all project personnel and consultants. All- project personnel at Brookfield Zoo and Columbus Zoo will also consult with Dr. Adey for one hour each month via a conference call. These activities will be carried out for the entire project period from 10/1/99 - 9/30/01. This will cover approximately 25 algae harvests which should be sufficient to meet our first objective to quantify the RATC nutrient removal efficiency.

Goal 2 (10/1/00 - 9/31/01): Using the data we obtained from the first year, implement RATC treatment in-line on Near Shore Waters for one year to maintain the target parameters phosphaete, and nitrite plus nitrate nitrogen at 0.03 - 0.05 mg/L and adjust ozone treatment to counteract discoloration of the exhibit water.

After one year, additional RATCs will be built that include recommended modifications from the first year's results. The number of contactors needed will be based on the RATC efficiency data determined in goal I and a known mean $P0_4$-P and Protein-N daily input into the exhibit based on food analysis. The RATCs will be installed in-line on the Near Shore Waters system in an adjoining room to the exhibit room and above the exhibit water level. They will be completely independent of the exhibit's main filtration system. Water will be pumped into the RATCs with a dedicated pump and will return to the exhibit by gravity. All of the same tasks carried out by the project personnel in the first year of the study will also be implemented in the second for each RATC, but will not require the dumping and filling of each RATC. If exhibit water discoloration occurs as a result of RATC treatment, ozone treatment will be gradually increased to compensate while still maintaining safe oxidation reduction potential levels in the exhibit.

Funding request: Funds are requested from IMLS for specific supplies, a Brookfield Zoo lab technician and a Columbus Zoo Intern salary for the two-year study period. Results of this study will be shared biweekly with the Columbus Zoo. Final results of this project will be made available to all zoo and aquarium institutions. A project paper will be presented to the Aquatic Animal Life Support Operators Association and another one to the American Zoo and Aquarium Association. The Water Quality Specialist will spend 4 hrs/week, The Living Coast Collection Manager will spend 2 hrs/week, The Aquatic Keeper will spend 2 hrs/week, The Living Coast Curator will spend 2 hrs/wk, Life Support Manager will spend 1 hr/wk, The Lead Life Support Operator will spend 1 hr/wk, Dr. Dubach will spend .5 hr/wk, the Columbus Zoo Curator will spend 2 hrs/wk, the Columbus Zoo Intern will spend .8 hr/wk, and Dr. Adey will spend 1 hr/ mo. for the two years of the study. A technician will assist the Water Quality Specialist with most of the analytical water testing 14 hrs / wk.

2. WHAT IS THE OBJECT(S), HISTORIC STRUCTURE(S), OR SPECIMEN(S) THAT IS THE FOCUS OF THIS PROJECT?

This project will help Brookfield Zoo maintain healthy animals in the 5 marine exhibits at The Living Coast. Near Shore Waters is our largest system and has the largest nutrient load due to the biology of the animals living there. It is interconnected with all other systems in the building through the backwash-recovery system; thus chemical changes in it gradually affect the same water quality changes in all of the smaller systems over time. Near Shore Waters is home to: (12) Humboldt penguins (Spheniscus humboldti), (0.0.2) swell sharks (Cephaloscyllium ventriosum), (2.1.0) horn sharks

(Heterbdontusfrancisci), (0.0.5) California moray eels *(Gymnothorax mordax),* (0.0.8) white sea bass *(Atractoscion nobilis),* (0.0.2) kelp bass *(Paralabrax clathratus),* (0.0.2) spotted sand bass *(Paralabrax maculatofasciatus),* (0.0.3) - barred sand bass (Aralabrax nebulifer), (0.0.5) popeye catalufa (Pristigenys serrula)- - starting to show breeding behavior, (0.0.3) ocean whitefish (Caulolatilus princeps), (0.0.27) pacific halfmoons (Medialuna californiensis), (0.0.14) blacksmith damselfish (Chromis punctipinnis), (12) chitons, and (500) turbo snails.

Other marine inhabitants in the building include:
(1.7.0) bonnethead sharks (Sphyrna tiburo), (2.3.0) pacific seahorse (Hippocampus ingens) -- for breeding program, (0.0.2 1) cardinal fish (Apogon sp.), (0.0.20) lookdowns (Selene vomer), (0.0.1) three-banded butterfly fish (Chaetodon humeralis), (0.0.3) blue-banded gobies (Lythrypnus dalli), (500) moon jellyfish (Aurelia aurita) -- in a breeding program, and (0.0.2) spiny lobsters (Panuliris interruptus).

All of the above animals will reap the benefits of maintaining low nutrient pollution levels in their systems.

3. HOW DOES THE PROJECT RELATE TO YOUR MUSEUM'S ONGOING CONSERVATION ACTIVITIES? Brookfield Zoo has a strong commitment to conservation with programs in the United States and abroad. It has a leadership role in SSP and studbook programs and has active research programs in population biology and genetics, ecology, behavior, nutrition and reproduction. Brookfield Zoo has received multiple awards for achievements in captive breeding programs. Eleven endangered species are currently breeding in the Zoo. It has received 8 IMS/IMLS Conservation Project grants in the past. The most recent one was in 1998 to assess genetic variation in the captive Humboldt penguin (*Spheniscus humboldti*) population and compare this variation with two wild populations in Chile. Currently, 12 of these penguins are residing in the Near Shore Waters exhibit at our Living Coast facility.

The taxonomic groups that have been affected the most by the rapid decline in species diversity in recent history are birds, amphibians and reptiles, fish and invertebrates. As a conservation institution, this makes it a high priority for us to do what we can to support SSP programs for these species and responsibly maintain their ever-increasing numbers within our care. Instead of continuing to use "borrowed" technology from the swimming pool and wastewater treatment industries, we feel we have an obligation to develop water quality technologies specific to the needs of our aquatic animals. This project will meet our zoo's greatest collection care need because many "environmentally fragile" aquatic species have recently entered into our care (*ie. Living Coast species*), and we have made it our priority to ensure that we will be able to meet the challenge of providing them with more healthy aquatic environments for them to live in.

Brookfield Zoo offers genetic services that are free of charge to all zoological institutions in North America through a laboratory that was partially funded through an IMS grant in 1989. Since September 1989, the lab staff have processed 1,716 blood and tissue cultures for 132 institutions from the United States, Canada, Mexico, Guatemala, and Panama. Karyotype data and remaining frozen blood/tissue samples are banked and available to researchers requesting information or samples.

4. WHAT ARE THE ANTICIPATED BENEFITS OF THIS PROJECT?
The primary benefit is to adapt the Smithsonian microcosm technology for research systems to modern zoo and aquarium use. This system will be able to maintain nutrients, pH, and dissolved oxygen in closed aquatic systems at natural levels, levels that are impossible to achieve with traditional filtration methods. Many physiological imbalances can be corrected using this technology. For example, high nitrate levels alone can cause the proliferation of nitrate utilizing bacteria like Pseudomonas and Aeromonas, which can be pathogenic to animals. High phosphate levels interrupt the calcification process in some animals. An unstable pH causes physiological stress in most amphibians, fish and invertebrates. Low dissolved oxygen levels cause asphyxiation in fish and invertebrates and can cause dangerous spikes in toxic ammonia due to losses of aerobic nitrifying bacteria. High nutrient levels also cause a proliferation of unwanted slime algae which can coat an entire exhibit in one day and greatly increase a Zoo's labor costs for cleaning.

After successful testing and implementation, the RATC design will be shared throughout the zoo and aquarium industry. There are over 180 institutions in the US alone who could benefit from this information. Inhabitants of The Living Coast facility are the first animals to benefit from this technology in our park. There are many aquatic birds, mammals, fish and invertebrate systems throughout our park and in other zoos and aquariums that will also benefit from implementing this technology into traditional closed aquatic systems. From alligators to polar bears, these systems are traditionally dumped

and filled with freshwater several times a week for maintaining water quality because a more feasible method for maintaining low nutrient levels over time (and therefore low bacteria and algae levels) is not currently available in the exhibits. In our park alone, there are hundreds of animals representing over 50 species that could benefit from this technology. Algal turf scrubbing has been clearly shown to be effective in all types of freshwater and marine aquatic systems (Adey and Loveland, 1998).

Across our country, as the quality of city water becomes less reliable and its use a higher conservation priority, dump and fill systems in zoos and aquariums will no longer be practical or desirable. We need to be in the business of developing a recycling alternative that is practical, feasible, and does not jeopardize animals or the environment. Results from this project will help Brookfield Zoo and other institutions like ours **to** take similar initiatives.

Utilizing natural filtration processes like algal turf scrubbing not only allows us to better maintain, propagate, and study endangered aquatic species, but it also allows us to study and better understand the processes themselves. This in turn helps us to persuade -our guests to make intelligent decisions in the conservation of these processes in the wild. Clean water is one of those precious natural resources we too easily take for granted.

Brookfield Zoo is dedicated to teaching our visitors conservation at the ecosystem level. Therefore over the past decade our aquatic exhibits have been evolving into multi-phyla aquatic systems like *Near Shore Waters* where aquatic birds, fish, and invertebrates share the same environment. This trend has allowed us to create fascinating immersion-style exhibits with strong conservation messages. Our *Swamp* (see photos 3 - *4)* and *Living Coast* buildings (see photos 1 - 2) are excellent examples of this. This trend has also made the effort to develop new filtration technologies like algal turf scrubbing a very high priority in order to meet the increased bioload demand of these systems. The education component of this project is to teach hundreds of high school students every year about the natural process
of algal turf scrubbing at the Brookfield Zoo and in the wild. This will be accomplished through our Education Department using RATC simulation software and by demonstrating an actual RATC in action.

5. HOW WILL THE APPLICANT ENSURE THAT ONGOING MUSEUM FUNCTIONS ARE NOT INHIBITED BY THESE PROJECT ACTIVITIES?

The implementation of the algal turf scrubbing system on Near Shore Waters will have no impact on its normal operation or appearance but to improve its water quality. The use of the space in either of the service rooms where the water treatment will be implemented will not impede normal operations of the facility in any way. The Goal 1 installation has a high capacity floor drain which would easily catch all of the RATC system water in the unlikely event of a flood or leak. The goal 2 installation will be above theexhibit water line and independent of the main filtration system. An overflow standpipe returning to the exhibit will be installed on each RATC to prevent any unlikely flooding. If exhibit water discoloration occurs as a result of RATC treatment, ozone treatment will be gradually increased to compensate while still maintaining safe oxidation reduction potential levels in the exhibit. This will prevent over-treatment with ozone.

The WQL is fully funded by the Chicago Zoological Society and is charged with serving the needs of Brookfield Zoo. This project is consistent with that mission and ongoing service work and studies will not be disrupted since staff and funds are in place for existing work. There is adequate workspace for an additional technician, and equipment is not used at maximum capacity. The water quality laboratory is closed to the public and will not affect normal operation of the Zoo in any way. While Zoo staff involved in the operation and oversight of The Living Coast will serve on the project team, their time commitment is minimal and will not impact their normal work.

6. WHAT ARE THE PROPOSED CONSERVATION METHODS AND WHY ARE THEY CONSERVATIONALLY SOUND?

Algal turf scrubbing was developed by the Smithsonian Marine Systems Laboratory researchers in the modeling of natural marine ecosystems. As used here, an ecosystem is a community of species interacting to process energy and nutrients through a complex of food webs. In natural systems, it is the role of plants to continually acquire nutrients from the water to build their tissues. There is a tremendous amount and variation of bacterial activity in aquarium systems causing the rapid accumulation of nutrients. Without massive water changes, these nutrients can accumulate in an aquarium system to detrimental levels or they can be assimilated into plant tissue by photosynthesis, the idea of the algal scrubber.

Like many other Zoos and Aquariums around the world, we have investigated many methods for controlling high nutrient levels in closed recirculating systems as alternatives to wholesale water changes with costly artificial seawater. Chemical ion exohange and bacterial bioremediation methods do work with high enough doses, but have proven to be costly and are too specific to manage the whole problem. Bacterial denitrification with methanol injection is effective for maintaining $N0_2$-N + NO_3-N levels around 5 mg/L, but this is still over 1000 times higher than natural levels and it is an inefficient process -

producing a high level of organic wastes. Lower levels of nitrate can be maintained, but carry a potential for contaminating the system with toxic levels of hydrogen sulfide. Algal turf scrubbing, the use of algal colonies to biologically control water quality parameters in a system, is the only method that can maintain low nutrient levels across the board while at the same time managing dissolved oxygen and pH levels for the optimum health and well being of our animals. In every way algal turf scrubbing is a conservationally sound method for creating healthier more naturalistic environments for aquatic animals.

We believe our method for providing a high rate of plant production in a compact filter component is innovative and practical enough to be incorporated into every kind of traditional filtration system, thereby naturally enhancing all types of artificial aquatic environments. With such a wide application spectrum, we believe this method warrants further development.

The PO_4-P analyses will be conducted in the Brookfield Zoo's water quality lab immediately after collection using the widely used Acid Persulfate Digestion Method (HACH Water Analysis Handbook, 1997). NO_2-N + NO_3-N testing will be conducted on preserved samples at the Shedd Aquarium using established marine water methods on a Dionex ion chromatograph. The method uses ion-exchange separation with conductivity detection. Samples will be preserved by adjusting pH to 2 or less with concentrated sulfuric acid and storing at 4 °C (HACH Water Analysis Handbook, 1997). The EMS water quality sensors have been in use at the Zoo for two years with good accuracy in marine systems.

7. H0W DOES THE PROJECT BUDGET SUPPORT THE GOALS AND OBJECTIVES?

Funds requested in this proposal will cover the costs of RATC environmental data logging (monitoring system, tachometer, photometer, flow meter, water quality probes), analytical testing at the Zoo (PO_4 reagents) and the Shedd Aquarium (IC column), and 24 algal turf community identifications by Dr. Adey. These test data will be critical in the evaluation of RATC performance and operational criteria. Funding is requested for a part-time lab technician and an intern salary for 24 months. Salary was calculated at a senior seasonal employee rate used at Brookfield Zoo for the technician and the standard Columbus Zoo intern rate for the intern. This amount of analytical testing and data processing cannot be accomplished without a lab technician at 14 hr. per week at Brookfield Zoo and an intern at 8 hr. per week at Columbus Zoo during the course of the project. Funds are also requested for travel expenses for one Columbus Zoo and two Brookfield Zoo project personnel to travel to Washington DC for a one day seminar by Dr. Adey for training. This will be critical training at the Smithsonian by Dr. Adey to ensure that all involved start off with a clear and common understanding of the scope and details of the project.

8. WHAT ARE THE QUALIFICATIONS OF THE PROJECT PERSONNEL?

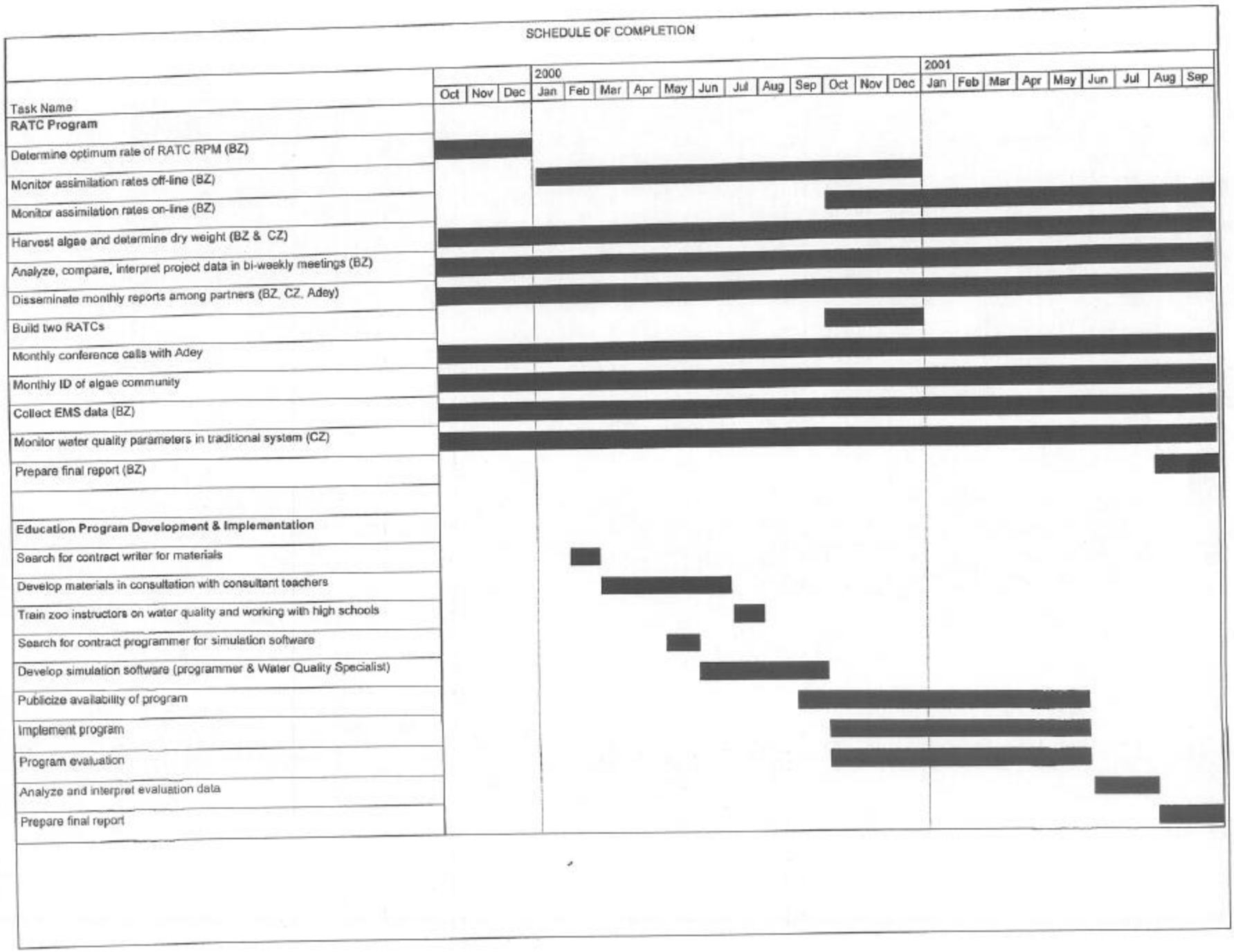
The Project Consultant, Dr. Walter Adey has been working on the development of living ecosystems modeling and algal turf scrubber technology for 25 years at the Smithsonian's Marine Systems Laboratory. In recent years, he has applied this technology to large-scale applied water-quality treatment systems in aquariums, aquaculture, and wastewater purification. He has written numerous papers, many of which have been cited in this application narrative.

The Water Quality Specialist, Kent Semmen has seven years experience working at Chicago's John G. Shedd Aquarium. He worked for 1 1/2 years as a Special Projects Aquarist in charge of developing specialized filtration and lighting for marine fish and invertebrate exhibits. He worked 5 1/2 years as the Manager of the combined Water Quality, Microbiology, and Veterinary Laboratory. For the last 2 1/2 years, he has worked as the Water Quality Specialist at the Brookfield Zoo managing the staff and systems responsible for maintaining healthy environments for all of the aquatic animals in the Zoo.

Lee Jackson has 15 years experience working as a keeper in zoos and aquariums. He has 5 years experience working with a Smithsonian-designed living reef microcosm exhibit incorporating algal turf scrubbing.

Additional Brookfleld Zoo project staff include Dr. Patty McGill, Curator of the Living Coast; Dr. Jean Dubach, Zoo Geneticist; Manny Onate, Living Coast Senior Aquatic Keeper; Pat VanDuyne, Life Support Manager; Dave Derk, Lead Life Support Operator, and a project technician. Columbus Zoo project staff include Mike Brittsan, Curator; and a project intern.

SCHEDULE OF COMPLETION



1999 IMLS Conservation Project Support Application Form

Project Budget Form

SECTION 3: SUMMARY BUDGET - CP AND EDUCATION COMPONENT

Name of Applicant: Chicago Zoological Society

IMPORTANT! READ INSTRUCTIONS IN PART 4 BEFORE PROCEEDING.

DIRECT COSTS	IMLS	MATCH	TOTAL
SALARIES AND WAGES (PERMANENT STAFF)	$ 900	$27,731	$28,631
SALARIES AND WAGES (TEMPORARY STAFF HIRED FOR PROJECT)	$23,166	$ 875	$24,041
FRINGE BENEFITS	0	$10,869	$10,869
CONSULTANT FEES	$ 5,650	0	$ 5,650
TRAVEL: DOMESTIC	0	0	0
FOREIGN	0	0	0
SUPPLIES & MATERIALS	$14,929	$ 1,200	$16,129
SERVICES	$ 4,400	0	$ 4,400
OTHER	$ 198	0	$ 198
TOTAL DIRECT COSTS	$ 49,243	$ 40,675	$ 89,918
INDIRECT COSTS*	$	$ 9,240	$ 9,240
TOTAL PROJECT COSTS			$ 99,157

* *If you do not have a current Federally negotiated rate, your indirect costs must appear in the Match column only.*

AMOUNT OF CASH—MATCH	$49,915
AMOUNT OF IN-KIND CONTRIBUTIONS—MATCH	$ 0
TOTAL AMOUNT OF MATCH (CASH AND IN-KIND CONTRIBUTIONS)	$49,915
AMOUNT REQUESTED FROM IMLS	$ 49,243
PERCENTAGE OF TOTAL PROJECT COSTS REQUESTED FROM IMLS (MAY NOT EXCEED 50%)	50 %

Have you received or requested funds for any of these project activities from another Federal agency? *(please check one)* ☐ Yes ☒ No

If yes, name of agency _____ Date _____

Amount requested $

EDUCATION COMPONENTS

New England Aquarium
Massachusetts
Education Component

1. What is the design of the Education component?

The New England Aquarium (NEAq) education department will develop a companion education program designed to inform our visitors about the IMLS conservation improvement project taking place behind-the-scenes and the importance of water quality to the collection animals in the *Caribbean Coral Reef* exhibit and all aquatic life. The education program will have two core components: an education program for visitors and an internship for urban teens. The goals of the education project are:

- to inform visitors about the IMLS conservation improvement project
- to educate visitors about the importance of water quality to the health of the collection animals and all aquatic life
- to create a new advanced teen internship position in the water quality department.

Visitor Education Program Activities

NEAq education staff, volunteer guides and teen interns present a variety of easily accessible programs for visitors of all ages. Daily programs include roving discovery carts, live animal "interviews", sea lion shows, "tank talks" at the top of the *Caribbean Coral Reef* guided interpretation at exhibits such as the *Edge of the Sea* and "Ask the Vet" sessions at the *Aquarium Medical Center.* NEAq's teen interns will work with the water quality analyst and supervisor of visitor education to design and present a new series of hands-on activities, demonstrations and presentations about the conservation improvement project made possible by IMLS. Proposed activities include:

- a water quality cart featuring hands-on activities such as water quality testing and graphing
- a model of the new life support system
- a graphic panel about the conservation project
- daily presentations about the *Caribbean Coral Reef* exhibit incorporating information about the project
- take-home fliers for visitors who wish to learn more

The water quality cart will feature hands-on activities about water chemistry including ph, temperature, turbidity, dissolved oxygen, and nutrient levels, and the effects that these various properties have on the exhibit and the collection animals, such as increased algae growth, poor visibility, stress, and the potential for disease. Visitors will be able to test the water from the *Caribbean Coral Reef exhibit* and graph the results, which will become part of the conservation project's water quality data. Once the new life support system is activated this data will become part of the ongoing project evaluation.

The model of the new life support system will demonstrate how the new protein skimming technology works, and educate visitors about how different life support systems maintain water quality in aquariums. The graphic panel will present images and text describing the IMLS conservation work being done behind-the-scenes.

Daily exhibit presentations are a core component of NEAq' s visitor education program and we will incorporate information about the IMLS conservation project into the *Caribbean Coral Reef* presentations. Related take-home information will instruct visitors on how to conduct simple water quality experiments at home or at the beach, pond or stream.

Advanced Teen Internship in Water Quality

The Aquarium has a comprehensive Teen Internship Program for inner-city Boston high school youth.
The summer program offers paid internships to almost 100 teens from inner-city Boston neighborhoods.
A smaller academic-year program provides work opportunities for 20 teens who have completed one summer to work after school, on weekends and during school vacations. Teen interns work in the education department as exhibit interpreters, answering visitor questions and offering presentations based on exhibit animals and environments.

The new advanced teen internship in water quality will provide opportunities for interns who have completed at least one summer or academic-year internship to become "water quality specialists" through in-depth training with NEAq's water

quality analyst. After successfully completing a basic knowledge assessment developed by the analyst, the teen interns will work with the visitor education supervisor to develop, prototype and evaluate visitor education activities.

Staff Time

- Water quality analyst: 4 hours per week for one month for training; bi-weekly check-ins during going activities and presentations.
- Visitor education supervisor: 4 hours per week for 2 months for activity development; 2-4 hours/week during ongoing activities and presentations.
- Supervisor of youth programs: 2-4 hours per week to monitor teen intern progress.
- Evaluator: 10 days for program evaluation including influence on interns and visitors.
- Director of education: 2 hours per week for overall program supervision.

Time Line

The timeline of the education project will correspond to the conservation improvement project. The education project will begin in June with the training of the selected teen interns. Design, prototyping and testing the hands-on activities, construction of the model and production of the graphic panel will begin in June. Teens will introduce the education activities to our visitors in late July. This timeline will keep our visitors informed about the ongoing work behind-the-scenes. Once the new life support system is installed, data gathered from daily tests conducted at the water quality cart will be used in the evaluation of the new system.

2. What are the anticipated benefits of this educational project?

Water quality is foundation of all aquatic life, yet most Aquarium visitors are not aware of the complex life support system that maintains this foundation in our exhibits. This education project presents an outstanding opportunity to educate our visitors about this little known part of the Aquarium. The project will produce new hands-on activities to educate our visitors about the importance of water quality for our collection animals and will provide new opportunities for urban teens both to broaden their knowledge of aquatic science and advance within the Aquarium. The new water quality activity cart produced by the project will become an integral part of NEAq's ongoing visitor education program.

3. How does the project budget support the education component goals and objectives?

All salary information is based on current salaries for staff members involved. The budget will support staff time for an educator to develop and implement each component, a water quality analyst to coordinate teen interns training and a portion of the teen interns stipend for the 2000-01 academic year. Program materials are the other primary project cost. These costs were derived from review of laboratory catalogues, and these materials will be adapted for use in the water quality cart, water quality presentations, and the model and graphic panels. Aquarium matching funds include in-kind contributions of staff time, evaluation, and the value of volunteer efforts in implementing the project.

4. **What are the qualifications of the project personnel?**

Christene Freedman, supervisor of visitor education, manages educational and interpretive programs for the New England Aquarium's education department. She is responsible for supervising volunteers and interns, coordinating and teaching the Aquarium Guide training class, and developing and implementing education programs for 1.3 million visitors a year. Ms. Freedman has several years of informal science teaching experience and has been working at the Aquarium for the past two years. She will supervise the development of educational activities, consult on the education content of the program and train the teen interns presenting the programs Aquarium visitors.

Cindy Cheney, supervisor of youth programs, has spent the past two years revitalizing and expanding the Aquarium's teen internship program to its current capacity. Aquarium youth programs offer jobs and volunteer positions to over 250 middle and high school students every year. Before coming to the Aquarium, she taught science in Texas and founded a community internship program for high school students at a Boston charter school, She will recruit the teen interns and monitor the teen intern progress.

Susan Goodridge, water quality analyst will provide technical expertise for the educational program and training the teen interns. She has managed the water quality of New England Aquarium's exhibit environments for the past year and was previously involved in oil spill clean up management. Ms. Goodridge is a certified in K-12 math and science teacher.

William Spitzer, director of education, will be responsible for the overall direction of the project, including coordination with the conservation component. He is responsible for overall leadership, development, delivery and evaluation of education programs reaching over 1 million Aquarium visitors, youth, and community members. Before coming to the Aquarium in

1996, Dr. Spitzer had over seven years of experience at TERC directing research and development projects in science education. Dr. Spitzer brings extensive experience in informal science education and curriculum development, as well as a background in physics, chemistry and oceanography. He holds a Ph.D. in Oceanography from MIT and the Woods Hole Oceanographic Institution.

1. What is the design of the education component?

The goal of this component is to introduce to a lay audience concepts of preventive conservation for natural history collections, and how the Museum applies these principles to extend the useful lives of specimens. We will draw examples from our Mammal Upgrade Project, the focus of our 1999 IMLS-CP project and proposed 2000 IMLS-CP grant, to highlight the project and to illustrate how we apply preventive measures to minimize risk to the specimens. Examples of mammalian taxidermy mounts will be included from the Resource Center collections in the Education Department, allowing us to relate the preventive conservation concepts to use of specimens in classrooms by docents and teachers. The primary targets for this educational project are English and Spanish-speaking individuals who use the collections for research, teaching, exhibition and artistic reference (researchers, docents, teachers, artists), individuals with an interest in "behind the scenes" at the Museum or an interest in protecting their own collectibles (Museum members, Elderhostel classes, the general public), and centers of informal learning (e.g., nature centers) without professional curatorial staff.

We have identified four concepts that need to be addressed through the products of this education component. We need to clarify the role of specimens and documentation as resources for research, teaching and exhibits. Collections of natural history specimens derive their value from use in research, teaching, exhibition and artistic reference; that value depends on the existence not only of the specimen, but the documentation as well. Some collections (e.g., the Education Department's Resource Center) are heavily used; others, such as the research collection, are used more intermittently but over a longer time period. Yet, we need to stress that specimens are non-renewable resources. Because each specimen is representative of a unique time and geographic location, it has unique attributes and is irreplaceable. Damage to the specimen, or loss of documentation, represents a direct loss of value of the specimen for its intended use, whether for education or research. We need to explain the balancing act of specimen use with specimen preservation; that is, the Museum applies principles of preventive conservation to maximize the value of specimens in our collections through their intended uses over a longer time period. This concept incorporates human safety concerns as well as basic issues for handling, storing and displaying specimens. To stress the relevancy of these concepts, we need to illustrate that steps taken in the museum setting can be applied for collections in homes, schools, and nature centers. This concept will be accompanied by suggestions for additional reading and sources for contacting professional conservators to evaluate needs.

To present these concepts we will develop three products: a series of web pages; a printed handout to accompany loans from the Mammal collection and Resource Center collection; and a workshop with handouts for docent training. We will develop text and illustrations for approximately 20 web pages for the Museum's web site (www.sdnhm.org). Each page will be developed following our web site style sheet and protocol, and will include photographs or graphics to illustrate the concepts primarily using examples from our upgrading of the mammal collection. One page will refer visitors to additional sources of information, publications and referral services (e.g., the Society for the Preservation of Natural History Collections, American Institute for Conservation). The information provided on the handout will be a synthesis of the web pages, using a style of presentation more appropriate for easy reference by individuals borrowing specimens. Both the web pages and the printed handout will be translated into Spanish. The workshop will introduce Museum docents to the project concepts using the handouts and web pages, with attention given to how docents should handle and care for the specimens they use in classes. The workshop will also discuss how docents can incorporate information about preventive conservation into their presentations in school classrooms. These three products will also be evaluated by the Museum's exhibit master planning team for development of an exhibit in our new facility.

Schedule: (1) We will complete front-end evaluation at the beginning of the project (May 2000) to help us focus the content and interpretive methodology, so that our products will convey effectively information about preventive conservation. This step will help us identify the level of existing knowledge about the four concepts listed above, and degree of interest in more detailed information. The evaluation process will be developed and implemented by Nancy Owens Renner (Exhibit Developer and Evaluator), Dr. Paisley Cato (Curator of Collections), Adrienne Russell (Collection Care Assistant) and Suzanne Anderson (Education Resource Center Coordinator). Owens Renner is leading the Museum's evaluation efforts in concert with the master planning process for new permanent exhibits. Cato uses survey methodology for her research in museums and has experience with questionnaire design and analysis. Anderson will provide input concerning education parameters and the perspective of those who use the Resource Center collections. Russell will work with Anderson and Cato to implement the evaluation process and analyze results.

(2) With results from the evaluation, Cato and Russell will draft the text and initial layout for the web pages and printed material (May-July). Graphic and layout assistance will be provided by the Museum's Graphics Designer (Erik Bolton), and the web page programmer (a contractual service). The text will be reviewed by Anderson and a conservator (Diana Dicus), then revised before translation into Spanish. During the review/revision period Russell and Cato will also

obtain images for the web pages (July-Sept).

(3) During the fall (Oct-Dec), we will finalize the pages on the web site and complete production of the printed handouts. We estimate 45 web pages total (20 in English, 25 in Spanish). Russell and Anderson will also develop the workshop for docents, holding the first workshop in January 2001.

(4) During the next five months (Jan-May 2001), the products will be used and evaluated through written survey forms. Results of the evaluations will be summarized by Russell and Cato at the end of May, and the web pages and handouts revised as needed during June. Workshops for docents will be held twice each year.

This schedule is appropriate for several reasons. Beginning in May insures the availability of target groups for front-end evaluation, before docents and individuals who borrow from the Resource Center finish their academic year in early June; most docents do not work over the summer and the Resource Center is closed for inventory and refurbishing the collection. Anderson has more time during the summer months than the academic year to participate in the development and production of the web pages and handouts. This also permits a cycle where the products can be used and evaluated during the busy spring months of the following year. In addition, this schedule allows us to overlap with the two phases of the Mammal Upgrade Project. One emphasizes the study skin material; the other emphasizes the skeletal material. We will use examples from both the study skin and skeletal material to illustrate how preventive conservation is used in the Museum.

The team for this project brings together strengths in collection care and conservation, education, evaluation, and interpretive techniques, and the times allotted by team members reflect total time spent over the 14 month duration of the project. The project will be led by Cato (5% time) and Russell (364 hours). A consulting conservator, Diana Dicus, who will review text for accuracy and emphasis, has estimated 8 hours for the review. The Education Resource Center Coordinator (Anderson) will commit a total of 208 hours. The Exhibit Developer and Graphic Designer will each provide 40 hours to the project. Web page production is based on the number of pages to be produced, and translation services are contracted with the firm which translates our exhibit labels and other printed copy.

2. What are the anticipated benefits of this educational project?

We anticipate both direct and indirect benefits from this project. The most direct impact will be the availability of products to assist us with our on-going campaign to educate our audience of the need to balance the competing principles of specimen use and long-term preservation. Our Mammal collection is used by researchers and collegiate-level students; many of the latter never receive instruction in preventive conservation or the potential impact of misuse of specimens. The products from this project will allow us to educate this audience in a timely, effective manner. The same is true for the many teachers, docents, Girl Scout leaders and artists who use the Resource Center collections with no or little awareness of the need for preservation. Because the Museum's geographic focus and audience includes Southern California and Baja California, the Spanish language web pages and handout will enable us to serve our Spanish-speaking audiences as well. Thus we anticipate the most direct benefit to be enhanced care of our own collections while increasing the awareness by our collection users of basic principles of preventive conservation.

The indirect benefits will be more widespread, with a long-term life. Through our web pages, we can provide access to information about preventive conservation to individuals and organizations who do not necessarily visit the Museum or use our collections. These include colleges with courses in systematics, geological sciences, archeology, anthropology, and museum studies; nature centers and small museums without professional collection staff; and individuals with interest in maintaining personal collections. Many of the latter contain organic materials such as those found in mammal collections, the focus of our project. We will be able to serve as a source of information and provide additional contacts and references for those seeking more detailed information. These products will also serve as the basis for developing an exhibit on the same topic for our expanded facility, and the results of the evaluation studies will help shape the interpretive technique and message for that exhibit.

3. How does the project budget support the education component goals and objectives?

The budget reflects the real costs of developing, implementing and evaluating an educational project with long-term viability and value. Costs of staff time are based on current salaries and fringe benefits. Funds requested to support Russell's time will allow her to participate in the project; she currently works 30 hrs/week, and the duties of this educational component are above and beyond her normal duties as manager for the off-site collections. Costs for acquisition of photographs, printing the handout, web page production and translation services are based on costs for recent projects completed in the graphics and education departments. Printing costs include printing of the draft version to be prepared in Dec 2000, and the final revised version to be printed in June 2001. The estimate for translation services is based on the recent translation of labels and brochure text for our exhibit, *Desert and Sea*. The time commitment by docents reflects the minimum estimated time for at least 15 experienced docents to participate in a 2 hour workshop as part of their continuing education. Additional time will be provided by docents during the evaluation exercises and a second

workshop for new docent training.

4. What are the qualifications of the project personnel?

Dr. Paisley S. Cato, Curator of Collections, will direct this project and supervise and train staff and volunteers. Dr. Cato has more than 20 years experience in the management and care of natural history collections and is currently responsible for developing and administering a museum-wide program for collections care and management. She has obtained and implemented 7 IMLS-Conservation Project grants since *1985*. Dr. Cato has presented papers and written extensively on research and issues of concern for collection care and management, with over 35 publications in professional journals and books. She also has experience developing and producing popular information about preventive conservation ("Caring for Your Collections", 1993. *Virginia Explorer*, Fall 1993. Virginia Museum of Natural History, pp 1-24).

Adrienne Russell has worked for the Museum in varying capacities since 1994. She was Resource Center Coordinator for three years and is very familiar with the needs of the collection and its users. Since 1998, she has worked for Cato as Collection Care Assistant, helping develop and implement logistics for the move of collections to the off-site facility, as well as manage that facility to care for the collections).

Suzanne Anderson, Resource Center Coordinator since 1998, has extensive experience as a biological educator in classroom, workshop and camp settings. As the Museum teacher for a pilot program called "Bridges to the Park," she led 15 classes (20 kindergartners each) as they learned about insects by looking at specimens, engaging in activities and exploring the Museum. A three-year docent at Torrey Pines State Reserve, she also has ten years experience in producing and directing educational video programs and documentaries.

Nancy Owens Renner, Exhibit Developer at the Museum since 1997, has a background in visual arts and over 10 years experience in graphic information design and visual communications in museums. Her understanding of scientific principles, knowledge of learning theory, and communication skills make her extremely well-suited for exhibit development. Her recent education includes studying evaluation techniques and Spanish. She currently supervises several interns in the evaluation of existing museum exhibits as part of the planning and design of new permanent exhibits.

Diana Dicus has more than nine years experience as a Conservator after receiving a Conservation Certificate in Archaeological Conservation and Materials Science from the Institute of Archaeology, University of London. Her experience teaching in preventive conservation has given her substantial experience working with non-professional audiences.

1. WHAT IS THE DESIGN OF THE EDUCATION COMPONENT?

The Tipton-Haynes Historical Association request funds in the amount of $9,175 to provide an education program to support the conservation of the four Samuel Shaver portraits of David Haynes, Rhoda Haynes, Landon Carter Haynes, and Eleanor Powell Haynes. The proposed project will include an adult component that will be a slide/lecture by the conservator, Cynthia Stow at the time of the Tipton-Haynes Historic Site's Grand Opening in November 2000 and a guidebook to accompany this program. For the young people in grades 4— 8, curriculum materials will be developed and a teacher workshop through East Tennessee State University Continuing Education held in June 2001. A special Girl Scout and Boy Scout Patch will be based on the developed materials and offered to this group along with patches already developed by the site. The materials will support the conservation of artwork to a region that has little awareness of art conservation. It is particularly important to reach the younger audience.

Goal of the project: The goal of the project is to provide educational programs based on the conservation work of four Samuel Shaver oil on fabric portraits of the Haynes family for the museum's adult audience, teachers, and young people in grades 4 - 8 in Northeast Tennessee.

Objectives of the project: The project will accomplish the following objectives:

- *To have the conservator present a slide/lecture at the site's Grand Opening of the Tipton-Haynes new Museum and Education Center and to develop a guide book for the adult audience to be used at the opening in November 2000 and for future visitors.* The guidebook (8-10 pages with color photos) will be developed by the director of Tipton-Haynes with the help of Cynthia Stow, conservator. It will describe the provenance of the paintings, information about the artist and the subjects, significance and documentation of the pictorial scenes that Shaver placed behind his subjects, and a detailed description of the conservation work completed at the Cumberland Conservation Art Center.

- *To develop a handbook of curriculum materials related to the portraits and their conservation for grades 4—8 to be used in the Northeast Tennessee region.* A handbook for educators will be developed under the consultation of Denee Mattioli, Ph.D., and faculty in the College of Education at East Tennessee State University. The Shaver portraits are rich in terms of the artist's pictorial scenes and their value as historical records. The process of conservation adds another dimension. Together, educational materials will be developed across the curriculum. In addition to the arts and history, materials will address language arts, geography, and the sciences. The handbook will include techniques geared for different leaning styles of the students. How a historical character can be brought to life based on the portraits or how people have captured their likeness—from the silhouette cutter, to the regional portrait painter such as Shaver, and on to the early history of photography up to 1870 are two examples. The process of the conservation of the painting will focus on the technical and scientific processes that will occur. The handbook will contain visuals such as slides and color photographs. The component parts of the handbook will allow educators to integrate materials into their teaching schedule. The director of the Tipton-Haynes Historic Site will coordinate the development of the curriculum with five days of consulting time provided by Dr. Mattioli.

- *To plan and implement a teacher training workshop through Continuing Education to orient regional teachers, home school teachers, and community leaders of the Girl and Boy Scouts and other educational organizations on how to use the curriculum materials.* Educators will be invited to a workshop in June 2001. The workshop will be part of East Tennessee State University's Continuing Education program. The workshop presenter will be Denee Mattioli, Ph.D. She will be responsible for the instructional design of the workshop and be the main presenter. Dr. Mattioli will provide fifteen days of consulting time. The director of the site will be responsible for the public relations and the flyer to be developed to advertise the teacher workshop. An evaluation instrument for the curriculum materials and workshop will be developed and used.

- *To work with our regional leaders of the Girl and Boy scouts to develop materials for a patch to be earned at Tipton-Haynes on conservation and collection preservation.* The director of the site has developed a Girl Scout Patch for Tipton-Haynes. This project will use the materials developed for the teacher workshop and modify them for use with the Boy and Girl Scouts. This patch will be offered to the scouts at the convenience of the leaders and will become an ongoing program.

Project timeline: The Education component will begin upon notification of the IMLS grant in May 2000. All parts of the project interrelate. The guidebook to be developed with the support of Cynthia Stow, conservator will be used as part of the curriculum materials designed for the educators. The curriculum materials will be used to develop the patch for the Boy and Girl Scouts. Therefore, the guidebook will be the first to be developed. It will be completed for the Grand Opening of the new museum in November 2000. At that time, Cynthia Stow, conservator will present a slide program on the conservation of the paintings. In order to plan a workshop for teachers that will be taught through Continuing Education at East Tennessee State University, an application needs to be submitted in September 2000 for a workshop in June 2001. This will allow enough time for the project coordinator, the director, Penny McLaughlin and the consultant, Dr. Mattioli to develop and print the curriculum materials and plan the instructional design of the workshop.

The schedule of completion is appropriate because there is adequate time to accomplish all of the objectives and that the materials to be developed will be based on the initial development of the guidebook.

Products: The products that will result from the Education Component are a guidebook for use at the Grand Opening in November 2000 and for future visitors to the exhibit of the four Shaver portraits; an educators handbook of curriculum materials; a Continuing Education workshop to be offered to educators in Northeast Tennessee; and the written specifications of a patch to be offered for Girl and Boy Scouts.

Relationship between the education component and conservation project: For each of the four products identified above, the process of the conservation of the four Samuel Shaver portraits will be a strong component. Over one-half of the guidebook will be devoted to the conservation of the paintings. At the time of the Grand Opening of the new museum, Cynthia Stow, Conservator will present a slide program that will inform and educate the adult audience about the specifics of their conservation. While the curriculum materials will be more diverse and include subjects across the curriculum, a minimum of one-fourth of the materials and the workshop will be devoted to the process of the conservation of the Shaver portraits.

2. WHAT ARE THE ANTICIPATED BENEFITS OF THIS EDUCATIONAL PROJECT?

The local and regional audience has minimal awareness of the need for professional conservation of oil on fabric paintings. The Grand Opening of the new museum is expected to attract over a thousand people and this is an opportune time to focus on the conservation of the portraits. The new museum is expected to bring an increased number of out-of-area visitors. The guidebook will help educate this audience. The goal of the site's ongoing educational programs has been geared toward the young person. The curriculum materials for teachers to use will further disseminate the subject of conservation of artwork. Tipton-Haynes has numerous Girl and Boy Scouts helping with volunteer projects and working on the Girl Scout Patch. This is a natural extension to an already existing audience. The project is geared to a regional audience. It is expected that the curriculum materials will be used not only by the educators who attend the workshop but also shared within their school systems

Continuing the project after the initial implementation stage: The guidebook will remain with the permanent exhibit of the four Shaver portraits. After the initial booklets have been disseminated, a small minimal charge will be added for visitors to purchase a copy in the museum store. It is planned to evaluate the teachers' workshop and to repeat it every other year, either under Continuing Education or making it into a college credit course that will make it self-sufficient. The scout patch will be integrated into other like programs and assumed by the site.

3. HOW DOES THE PROJECT BUDGET SUPPORT THE EDUCATION COMPONENT GOALS AND **OBJECTIVES?**

How the project costs were determined: Project costs were determined by actual prices of materials available in our area. The project director's fee is based on current salary.
Why the costs are reasonable & appropriate: The costs are reasonable because they are based on actual amounts from businesses in our area that will provide the services or materials.
Origin & relevance of project match: In-kind support from Dr. Denee Mattioli was determined by the amount she receives for consultation work, i.e. from $500 to $1,000 per day. Her fee for consultation for this project will be $500 per day.
Cost factors involved in selecting personnel materials, equipment, or scheduling: Dr. Mattioli has her students come to the historic site to participate in service-learning projects. This is the third year that students have used the site as a learning environment. She is willing to volunteer her time in support of this project and the site. The project is fortunate to have such a capable person.

4. WHAT ARE THE QUALIFICATIONS OF THE PROJECT PERSONNEL?

Denee Mattioli, Ph.D.: Dr. Mattioli has the academic credentials and the faculty position to plan and prepare a teacher handbook, to complete an instructional design for the workshop, and to be the presenter of the teachers' workshop. Of particular interest to this project is her development of two new courses for the college level - *Using the Arts to Teach American History* and *Using Dramatic Techniques to Teach History.* She actively works with teachers in the field and knows the regional education systems.

Jeannette (Pennvl McLaughlin, Ed.D: Dr. McLaughlin has been director of Tipton-Haynes since 1991. Her academic background includes a MAT from George Washington University in Museum Education. She developed a Heritage Adventure Program for school children, an eleven week Summers Past History Program for young people age 6-12, Educational Packets for teachers after a field trip to the site, and established a Junior Board for secondary students age 15-18.